This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

LELAND·STANFORD·JVNIOR·VNIVERSITY

570.5
A512

ANNEX

THE

AMERICAN NATURALIST,

AN ILLUSTRATED MAGAZINE

OF

NATURAL HISTORY.

EDITED BY

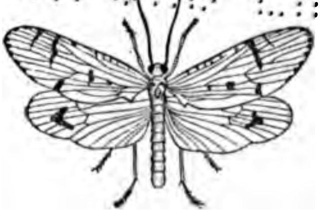
A. S. PACKARD, Jr. AND F. W. PUTNAM.

R. H. WARD,

ASSOCIATE EDITOR, DEPARTMENT OF MICROSCOPY.

VOLUME VIII.

STANFORD LIBRARY



SALEM, MASS.

PEABODY ACADEMY OF SCIENCE.

1874.

Entered, according to Act of Congress, in the year 1874, by the
PEABODY ACADEMY OF SCIENCE,
in the Office of the Librarian of Congress, at Washington.

146935

PRINTED AT
THE SALEM PRESS, F. W. PUTNAM & CO.,
Salem, Mass.

CONTENTS OF VOL. VIII.

Notes from the Journal of a Botanist in Europe. By W. G. Farlow, M.D. pp. 1, 112, 295.

Ornithological Notes from the South. By C.Hart Merriam. pp. 6, 85.

Botanical Observations in Western Wyoming. By Dr. C. C. Parry. pp. 9, 102, 175, 211.

Animal Life of the Cuyamaca Mountains. By Dr. J. G. Cooper. p. 14.

On the Relationship between Development and the Sexual Condition in Plants. By John Stockton-Hough, M.D. p. 19.

Rambles of a Botanist in Wyoming Territory. By Rev. E. L. Greene. pp. 31, 208.

The Present Aspects of Biology and the Method of Biological Study. By Professor Allman. p. 34.

The Yellowstone National Park. By Theodore B. Comstock, B. S. pp. 65, 155.

On the Structure and Affinities of the Brontotheridæ. By Prof. O. C. Marsh. *With two plates.* p. 79.

The Botany of the Cuyamaca Mountains. By J. G. Cooper, M. D. p. 90.

Science in the United States. From the French of Alphonse DeCandolle. p. 98.

Notes upon American Water Birds. By Robert Ridgway. p. 108.

Three different Modes of Teething among Selachians. By Prof. Louis Agassiz. p. 129.

The Wild Cattle of Scotland, or White Forest Breed. By E. Lewis Sturtevant. p. 135.

Exploration of the Gulf of Maine with the Dredge. By A. S. Packard, Jr. *Illustrated.* p. 145.

The Giant Cuttle-fishes of Newfoundland and the common Squids of the New England Coast. By Prof. A. E. Verrill. *Illustrated.* p. 167.

The Flora of Penikese Island. By Prof. D. S. Jordan. p. 193.

On Local Variations in the Notes and Nesting Habits of Birds. By Robert Ridgway. p. 197.

A new Species of Willow from California, and Notes on some other North American Species. By M. S. Bebb. p. 202.

The Robin. By Caroline Boyce. p. 203.

The Natural History of a Polymorphic Butterfly. By Samuel H. Scudder. p. 257.

The Game Falcons of New England. The Sparrow Hawk. By Dr. William Wood. p. 266.

Nature's Means of Limiting the Numbers of Insects. By A. S. Packard, Jr. *Illustrated.* p. 270.
Habits and Characteristics of Swainson's Buzzard. By Dr. Elliott Coues. p. 282.
Fossil Horses in America. By Prof. O. C. Marsh. *Illustrated.* p. 288.
The Preservation of Caterpillars by Inflation. By Samuel H. Scudder. *Illustrated.* p. 321.
Notes on the Cyprinoids of Central New Jersey. By Charles C. Abbott, M.D. *Illustrated.* p. 326.
The Migration of Birds. By T. Martin Trippe. p. 338.
On the Structure and Casting of the Antlers of Deer. By John Dean Caton, LL. D. p. 348.
The Classification of the Rhynchophorous Coleoptera. By John L. LeConte, M. D. p. 385. Concluded p. 452.
Observations on Drosera filiformis. By William M. Canby p. 396.
A Key to the Higher Algæ of the Atlantic Coast, between Newfoundland and Florida. By Prof. D. S. Jordan. pp. 398, 479.
Human Remains in the Shell-Heaps of the St. John's River, East Florida. Cannibalism. By Prof. J. Wyman. p. 403.
The History of the Lobster. By A. S. Packard, Jr. *With plate and cut.* p. 414.
Notes on the Flora of Southern Florida. By Frederick Brendel. p. 449.
Herbarium Cases. By Dr. C. C. Parry. *With cut.* p. 471.
Charles Robert Darwin. By Prof. Asa Gray. p. 473.
The Agricultural Ant. By Dr. G. Lincecum. p. 513.
Azalea viscosa, a Flycatcher. By W. W. Bailey. p. 517.
On the Antennæ in the Lepidoptera. By A. R. Grote, A.M. p. 519.
The Social Life of the Lower Animals. By Prof. P. J. Van Beneden. p. 521.
On the Distribution and Primitive Number of Spiracles in Insects. By A. S. Packard, Jr. p. 531.
Geographical Variation in North American Birds. By J. A. Allen. p. 534.
Experiments on the Supposed Auditory Apparatus of the Mosquito. By Prof. A. M. Mayer. *Illustrated.* p. 577.
The Gossamer Spider. By Dr. G. Lincecum. p. 593.
On the Nesting of Certain Hawks, etc. By Dr. Elliott Coues, U.S.A. p. 596.
The Metamorphosis of Flies. I, II, III. By Dr. August Weissmann. pp. 603, 661, 713.
Address of Prof. Joseph Lovering. pp. 612, 641.
English Sparrows. By Thomas G. Gentry. p. 667.
Imbricative Æstivation. By A. P. Morgan. *With cuts.* p. 705.
On the Cotton Worm of the Southern States (*Aletia argillacea* Hüb.). By Aug. R. Grote. p. 722.
Life Histories of the Protozoa. By A. S. Packard, Jr. *Illustrated.* p. 728.

REVIEWS AND BOOK NOTICES.

The Systematic Position of the Brachiopods (*Illustrated*) p. 43. North American Grasshoppers, p. 53. British Marine Seaweeds, p. 54. Lubbock's Monograph of the Poduræ, p. 54. New German Botanical Manuals, p. 115. The Mollusks of Western North America, p. 116. The Zoological Record for 1871, p. 180. Revision of the Echini, p. 215. Hayden's Geology of the Territories (*Illustrated*), p. 216. Girard's Insects, p. 221. Solar Physics, p. 222. The Birth of Chemistry, p. 222. North American Moths, p. 223. Surveys west of the 100th Meridian, p. 302. Check List of Coleoptera, p. 303. Dictionary of Elevations of the United States, p. 303. Flora of Colorado, p. 304. Young's Physical Geography, p. 353. Half Hours with the Microscope, p. 354. Field Ornithology, p. 418. The Butterflies of North America, p. 420. Deep Sea Floridan Polyzoa, p. 421. The Publications of the Buffalo Society of Natural Sciences, p. 421. List of North American Noctuid Moths, p. 421. The United States Fish Commission Report (*Illustrated*), p. 493. North American Flies, p. 497. The Unicellular Nature of the Infusoria, p. 498. Siebold's Anatomy of the Invertebrates, p. 499. Recent Publications on Ornithology, p. 541. History of North American Birds, p. 546. The Principles of Science, p. 628. Scammon's Marine Mammals of the Northwestern Coast and American Whale-fishery, p. 632. The Geology of the Lower Amazonas (*Illustrated*), p. 673. The original Distinction of the Testicle and Ovary, p. 680. Maps of Wheeler's Expedition, p. 683. Physiology of the Circulation, p. 684. Bulletin of the Cornell University, p. 684. Manual of Metallurgy, p. 684. Introduction to General Biology, p. 749. Publications of Wheeler's Survey, p. 749. The Geological Survey of Indiana, p. 749.

BOTANY.

Irritability of the Leaves of the Sundew, p. 55. Were the Fruits Made for Man, or Did Man Make the Fruits? p. 116. The Fertilization of Gentians by Humble Bees, pp. 180, 226. The Desmids, p. 181. Investigations respecting the Fertilization of Abutilon. p. 223. Abnormal Form of Allosorus acrostichoides, p. 304. Rumex patientia L. p. 305. The Northernmost flowering Plants, p. 305. The small-flowered Parnassia in Michigan, p. 305. The Fresh-water Algæ of North America, p. 306. Aplectrum hyemale again, p. 307. Development of Ferns without Fertilization, p. 307. Lobelia syphiliticæ v. alba, p. 307. Sex in Plants, p. 355. A New Ribes, p. 358. Periodic Motions of Leaves and Petals, p. 359. Ascent of Sap in the Bark of Trees, p. 360. Botrychium lunaria Swartz, in Michigan, p. 360. Absorption of Ammonia by the aërial parts of Plants, p. 360. Geographical Distribution of the Cupuliferæ, p. 422. Note on the Influence of Light on the Development of Plants, p. 425. Dr. Beardslee, p. 499. Double Thalictrum, p. 499. Dr. W. G. Farlow, p. 499. Distribution of Alpine Plants, p. 552. Amount of Water contained in the different parts of a Plant, p. 553. Botany of Wilkes' South Pacific Exploring

Expedition, p. 635. Influence of Forests on the Rainfall, p. 635. Insectivorous Plants, p. 681. Distribution of American Woodlands, p. 687. Adoxa Moschatellina L., in Iowa, p. 690. Dispersion of Seeds by shooting them off, p. 690. Botrychium lunaria Swartz, p. 691. Yucca filamentosa, p. 749. The Distinctive Features of Apple Flowers, p. 752.

ZOOLOGY.

A New Ægerian Maple Borer, p. 57. A Spinous Fin in a Minnow, p. 58. Capture of a Gigantic Squid at Newfoundland, p. 120. A New (?) Ægerian Maple Borer, p. 123. The Anatomy of Worms, p. 124. Entomology in Missouri, p. 181. A New North American Bird, p. 188. Economic Entomology, p. 189. Gigantic Cuttle-fishes of Newfoundland, p. 226. Laws of Geographical Variation in North American Mammals and Birds, p. 227. The Habits of Polistes and Pelopæus, p. 229. Notes on the Plant Lice, p. 231. A Straggler in the Ohio, p. 233. Assembling among Moths, p. 234. Organs of Hearing in Insects, p. 236. Change of Habit, p. 237. Spontaneous Generation, p. 238. Discovery of the Water Thrush's Nest in New England, p. 238. Two rare Owls from Arizona, p. 239. Avifauna of Colorado and Wyoming, p. 240. The Olive-sided Flycatcher, p. 240. A remarkable Peculiarity of Centrocercus urophasianus, p. 240. On a Hummingbird new to our Fauna, p. 241. Occurrence of Telea Polyphemus in California.—A Correction, p. 243. Identity of our Hydra with European Species, p. 244. Olive-sided Flycatcher, pp. 308, 309. Pet Spiders, p. 361. Reproduction of a Fish's Tail, p. 363. The Kinglets in New Jersey, p. 364. The Honey-ants, p. 365. Spizella Breweri (?) in Massachusetts, p. 366. The Chimney Swift: Change in Place of Nesting, p. 367. The Myriopod Cermatia poisonous, p. 368. Blind Crustacea, p. 368. Birds and Caterpillars, p. 368. A sinistral Helix albolabris, p. 368. Note on preserving Insects in Collections, p. 369. The Structure of Sponges, p. 425. Haeckel's Embryonal and Ancestral form of all Animals, p. 426. Temperature and Life of the Arctic Ocean, p. 426. A Worm with External Ovaries, p. 427. A Remarkable Beetle Parasite of the Beaver (with cut), p. 427. Tornaria not a larval Starfish, but the Young of a Worm, p. 429. The White-necked Raven, p. 429. Relation of the Cœlenterates and Echinoderms, p. 430. New Carboniferous Myriopods from Nova Scotia, p. 430. The Discovery of the Origin of the Sting of the Bee, p. 431. Deep Sea Dredgings in the Gulf of St. Lawrence, p. 431. The Mouth Parts of the Dragon Fly, p 432. A New Type of Snakes, p. 432 Notice of a Species of Tern new to the Atlantic Coast of North America, p. 423. The Ruddy Duck, p. 433. Birds New to the Fauna of North America, p. 434. On Some of the Evidences of Life in Great Salt Lake, p. 435. English Sparrows, p. 436. A New Group of Cyprinidæ, p. 436. A Horned Elotherium, p. 437. The Skunk, p. 437. The Redheaded Woodpecker in Maine, p. 437. Menobranchus edible, p. 438. New Crustacea of the Swedish Josephine Expedition, p. 438. Special Mode of Development of certain Batrachians, p. 438. The Paleontological History of

Trilobites, etc., as opposed by Barrande, to the Evolution Theory, p. 439. Monograph of the Whale Lice, p. 441. New Species of North American Bird, p. 500. Occurrence of Japyx in the United States (*Illustrated*), p. 501. The "Hateful" Grasshopper in New England, p. 502. The Kinglets in New Jersey, p. 502. Zoology in Belgium, p. 503. Recent Researches on Termites and Stingless Honey-bees, p. 553. The European House Sparrow, p. 556. Fish Culture in the Olden Time, p. 557. The Influence of the Nerves upon the Change of Color of Fish and Crustacea, p. 559. The Cotton Worm, p. 562. Larvæ of Anopthalmus and Adelops, p. 562. New Variety of Blue Grosbeak, p. 563. Dimorphism in Gall Flies, p. 563. Sweet Scented Ants, p. 564. Robber Ants, p. 564. Ichneumon Parasites of Anthrenus Larvæ, p. 564. Larvæ of Membracis serving as milk cattle to a Bee, p. 565. The Snow Goose, p. 636. Transformations of our Moths (*Illustrated*), p. 691. English Sparrows, p. 692. Monstrosities among Beetles, p. 693. Note on the Synonymy of Telea Polyphemus, p. 753. The Reversion of Thoroughbred Animals, p. 754. Deep Sea Explorations, p. 755. The Chestnut sided Warbler, p. 756. Embryology of the Brachiopods, p. 756. Metamorphoses of the Hair Worm, p. 757. A new Order of Hydrozoa, p. 757. Birds of Kansas, p. 757. Ostrich Breeding, p. 757. Case of a Dog nursing a Kitten, p. 758.

GEOLOGY.

Return of Professor Marsh's Expedition, p. 58. The N. W. Wyoming Expedition, p. 124. Monkeys in the American Miocene, p. 125. The Genus Protohippus, p. 126. Remains of Land Plants in the Lower Silurian, p. 190. The great Lava-flood of the West, p. 244. Deep-sea Explorations, p. 369. The Carboniferous Formation of South America, p. 441. Analogy of the Tertiary Fauna of France to the Temperate Regions of America, p. 442. Small size of the Brain in Tertiary Mammals, p. 503. Deep Sea Soundings, p. 504. Deep sea Temperature in the Antarctic Sea, p. 637. Origin of the Valley of the Rhine, p. 637. Supposed Lower Silurian Land Plants, p. 693. European Fossil Cetacea, p. 694.

ANTHROPOLOGY.

The Manufacture of Pottery by the Indians (*Illustrated*), p. 245. The Berries of Rhamnus croceus as Indian Food, p. 247. A human Skeleton from the Diluvium, p. 370. The Pygmies of Central Africa, p. 443. Troglodytes in Alaska, p. 505. Egyptian Archæology, p. 506. A true Geography of the Brain, p. 565. Rate of Growth in Man, p. 567. Extent of the Ancient Civilization of Peru, p. 637. Restoration of Indian Pottery, p. 694. The Earthworks of Fort Ancient, p. 759.

MICROSCOPY.

A New Section Cutter (*Illustrated*), p. 59. A New Form of Microtome (*Illustrated*), p. 126. Embedding Tissues for Sections, p. 191. Dissecting Embryos, p. 191. Holman's Siphon Slide (*Illustrated*), p. 248. Structure of the Potato, p. 248. Microscopic Drawing, p. 249. Air-cells in a floating Leaf, p. 250. Life of Hæmatozoa, p. 250. Finding the chemical Focus in Photomicrography, p. 251. A Spherical Diaphragm, p. 252. Leaf Sections, p. 252. Another Erector, p. 252. Cements, p. 252. Automicroscopy, p. 253. Measuring the growth-rate of Plants, p. 253. A revolving Amplifier, p. 253. Quieting Frogs, p. 253. On the Structure of Diatoms, p. 309. Unmounted Objects, p. 316. Arranging Diatomaceæ (*Illustrated*), p. 371. Histology, p. 373. Morphology of the Saprolegniei, p. 374. Section Cutters, p. 375. Lecture Illustrations of Microscopic Objects, p. 375. Podura Scales, p. 376. Lengthened Immersion Tube, p. 376. Automatic Turntable, p. 376. Origin of Blood Corpuscles, p. 376. Substitute for the Camera lucida, p. 377. Amphipleura pellucida in dots, p. 413. On Circulatory Movements in Vaucheria, p. 414. Improvements in Insect Mounting, p. 507. Measuring Angular Apertures, p. 508. Cataloguing Microscopic Specimens, p. 509. Sand-blast Cells, p. 510. Another Microscopical Cement, p. 510. New Application of Staining to Pathology, p. 511. New Rotating Microscope, p 567. Mounting Diatoms, p. 568. Blood Crystals, p. 568. Tolles' New Immersion 1-6th, p. 568. Sphæraphides in Tea Leaves, p. 638. New Microscopical Societies, p. 638. Appearance of the Blood in Melanosis, p. 638. Achromatic Bull's Eye Condenser, p. 638. Embedding Tissues, p. 639. Glycerine Mounting, p. 639. Beaded Silica Films, p. 696. Cell-culture in the Study of Fungi, p. 697. Handling Diatoms, p. 697. Reproduction of Desmids, p. 698. Angular Apertures, p. 698. A Finder for Microscopes with plain stage, p. 700. The Right-angled Prism as a substitute for the Mirror for transmitted light, p. 700. Apparatus for giving pressure to objects while drying, p. 700. The new Type Plate, p. 701. Fixing Diatoms, p. 701. The Podura Scale, p 702. Distribution of the Rhizopods, p. 761.

NOTES.—Pages 62, 128, 191, 253, 316, 377, 445, 511, 569, 639, 702, 762.

EXCHANGES. — Pages 256, 448.

BOOKS RECEIVED.—Pages 64, 128, 192, 256, 320, 384, 448, 512, 576, 704, 765.

ANSWERS TO CORRESPONDENTS. — Page 128.

ERRATA.

Page 58, line 10, for "Gernadius" read Gennadius. Page 114, line 3 from bottom, for "arising" read arriving. Page 115, for "Thorne" read Thomé. Page 237, last line, for "I. J. Wyman" read J. Wyman. Page 358, in the description of *Ribes Wolfii*, immediately after sp. n. insert (*R. Sanguineum* Pursh. var. variegatum Watson, 381 in King's Report, vol. v. p. 100) and change "3 to 6 feet high" into 2 to 4 feet high. Page 482, after the second "c" read "Branchlets mostly tapering to base," omitting "opposite and." Page 483, line 30 from top, for "g" read q. Page 485, line 16 from top, for "f" read f². Page 491, for numbers "150, 151, 152, 153, etc., to 194," read Nos. 149(2), 150, 151, 152, etc., to 193, each number having been by accident pushed forward, thus not corresponding with the references above. Thus Ulva Lactuca should be No. 161 instead of No. "162." Page 509, line 15 from top, for "slip" read slit. Page 546, 3d line from bottom, insert a comma after "century." Page 547, 10th line from bottom, for "of which the latter two," read, of which latter two. Page 551, 5th line from bottom, for "subi" read subis; 4th line from bottom, insert "no" before "similar." Page 552, for "J. S. Merrill" read J. C. Merrill.

LIST OF PLATES.

Plate.		Page.
1, 2.	Brontotherium ingens Marsh,	81
3.	Early Stages of the Lobster,	416

LIST OF WOOD-CUTS.

No.		Page.
1.	Lingula pyramidata, . . .	44
2.	Transverse section of Lingula.	44
3.	Transverse section of annelid.	44
4.	Transverse section of molluscan archetype, . . .	44
5.	Molluscan archetype, . .	44
6.	Embryo of Lamellibranchiate, ...	45
7–11.	Embryos of worms, . . .	46
12–17.	Embryos of Brachiopods, .	46
18.	Peduncle of Lingula pyramidata.	47
19.	Cephalic collar of Sabella, .	47
20.	Head of Discina, ...	47
21.	Head of Sabella, ...	47
22, 23.	Longitudinal section of Lingula and Amphitrite, .	48
24, 25.	Sections of arm of Amphitrite and Lingula, . . .	49
26–29.	Hairs of various shells and worms, ...	49
30–34.	Segmental organs of worms,	51
35–38.	Segmental organs of Brachiopods, ...	51
39, 40.	Segmental organ of Alciope and Terebratulina, . . .	52
41–43.	Section cutter, ...	60, 61
44.	Section of arm of squid, .	122
45.	Microtome, ...	126
46.	Aporrhais occidentalis, . .	128
47.	Yoldia thraciæformis, . .	128
48.	Macoma sabulosa.	128
49.	Mactra ovalis, ...	151
50.	Cyprina Islandica, ...	151
51.	Glycimeris siliqua. . . .	152
52.	Panopæa Norvegica, . . .	152
53.	Deltocyathus Agassizii, .	153
54.	Loligo pallida.	168
55.	Quill of Loligo pallida. . .	169
56.	Egg Capsule of Loligo Pealii, ...	170
57.	Embryo of Loligo Pealii, .	171
58.	Geyser-tube, ...	216
59.	Turban Geyser, ...	216
60.	Oblong Geyser near the Giant, ...	217
61.	Basins of Hot Springs, . .	218
62.	Menopon picicola.	219
63.	Goniodes Merriamanus, .	219
64.	Goniodes mephitidis, . . .	220
65.	Nirmus buteonivorus, . .	220
66.	Docophorus syrnii, . . .	220
67.	Cattle Tick, ...	220
68.	American Argas.	220
69–70.	Indian implements, . . .	245
71.	Siphon slide.	248
72.	Aphelinus of apple scale insect, ...	281
73.	Orohippus agilis.	289
74.	Miohippus annectens. . .	290
75.	Foot bones of Orohippus, Miohippus, Hipparion, & Equus, ...	202
76–77.	Preservation of caterpillars.	322
78.	Alburnus amœnus, ...	334
79–80.	Instruments for arranging Diatomaceæ.	372
81.	Embryo of lobster. . . .	415
82.	Platypsylla castoris, . .	428
83.	Herbarium cases, ...	472
84.	Lerneonema.	497
85–86.	Cirrhatulus grandis, ...	494
87.	Clymenella, ...	494
88.	Euchone, ...	497
89.	Zoëa of common crab, . .	495
90.	Megalops of common crab,	495
91.	Japyx solifugus.	501
92–100.	Geological Sketches of the Lower Amazonas, . .	674–679
101.	Larva of Cælodasys unicornis, ...	691
102.	Larva of Platycerura furcilla, ...	691
103.	Larva of Nadata gibbosa, .	691
104–105.	Larva of Notodonta, ...	691
106.	Larva of Cerura, ...	692
107.	" " Dipthera deridens,	692
108.	Cucullia speyeri, Male, . .	692
109.	" " Female, .	692
110–125.	Æstivation of Plants, .	706–709
126.	Bathybius Hæckelii, . . .	730
127.	Protomonas amyli, . . .	732
128.	Protomyxa aurantiaca, . .	733
129.	Vampyrellas pirogyræ, . .	735
130.	Myxastrum radians, . . .	736
131.	Gregarina gigantea, . . .	738
132.	Amœba diffluens, ...	741
133.	Amœba sphærococcus, . .	744
134.	Pelomyxa palustris, . . .	745
135.	Collosphæra spinosa, . . .	747

Archer [illegible]
Green [illegible]

THE

AMERICAN NATURALIST.

Vol. VIII.—JANUARY, 1874.—No. 1.

NOTES FROM THE JOURNAL OF A BOTANIST IN EUROPE.

BY W. G. FARLOW, M.D.

PART I. SWEDEN.

SWEDEN, and especially Upsala, is a sort of botanical Mecca, and, indeed, no one who has occasion to travel in the north of Europe would willingly refrain from visiting the tomb of Linnæus.

I reached this country by way of Copenhagen, which fine city, as well as Hamburg I was obliged to hurry through, taking merely a glimpse of the Botanical and Zoological Gardens. From Copenhagen I crossed over to Malmoe in Sweden, and took the train to the old university town of Lund, where the distinguished algologist, Agardh, is professor, as was his father before him. The town is, indeed, old and primitive: and from the astonishment of the natives one would suppose that I was the first American ever seen there.

A pretty, but to me decidedly unintelligible chamber-maid managed after a while to understand that I wanted a room. Unfortunately, there was no lock to the door, and servant after servant entered the room without going through the ceremony of knocking, and inspected me and my luggage. At length, a waiter appeared who spoke a little German and from him I learned that Prof. Agardh was in the city. With a porter to carry my large package of algæ, I made my way to his house, before the door of

---

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress at Washington.

which, and in the entries, juniper twigs were spread, a universal custom in Sweden. I found the professor at home and expecting me. In personal appearance he is tall, and, as they say, aristocratic looking (in fact he is called "Lord Agardh" by the students); he has bright twinkling eyes and a white mustache. He speaks and writes English remarkably well. He is a member of the Reichstag, and so goes to Stockholm in the winter. His herbarium, with the exception of the largest species, is in his private house. The larger specimens are kept at the building in the new botanical garden. An examination of the specimens I had brought was preluded by an invitation to take a glass of Cognac and soda-water, a favorite beverage in this region. My valise being unpacked, we set to work. Amongst the lot were several plants new to him from America, and some entirely new, particularly amongst my Oregon and California species; but this is hardly a proper time to notice new species. He seemed to be particularly interested in a specimen of *Pikea Californica*, which plant he had never seen, although he had himself added other members to the genus. A *Chordaria* from Oregon, supposed by Agardh to be new, I have since discovered, from an examination of the Ruprecht collection in St. Petersburg, to be *C. abietina* of Ruprecht, still unpublished.

The botanical department of the university is under the direction of Professor Agardh, assistant Professor Areschoug, nephew of the professor of the same name at Upsala, and Dr. Berghen, *privat-docent*, who has more especially studied mosses and was associated with Professor Theo. Fries of Upsala in his Spitzbergen journey. Dr. Areschoug speaks very little English, but delightfully slow German. Dr. Berghen speaks both English and German. He is going to New Zealand next year, and is to return by way of California.

The old botanical garden opposite the cathedral is now changed into a pleasure ground. The new garden is yet in its infancy, but the hot-houses are on a scale not to be seen in any American university. It seems strange to me that in these cold northern countries, among a comparatively poor people, the universities are provided with gardens and hot-houses which, if they belonged to most American universities, would be considered something wonderful. In fact, except in Berlin and Munich, I have seen no garden in Germany, so far as the hot-houses are concerned, equal to those at Lund. Near the entrance of the garden is a brick building containing a lecture room, laboratory, and herbarium. In passing through the hall a most decided and congenial aroma of seaweed was perceived. It appears that Professor Agardh keeps a woman pretty constantly employed in soaking out and mounting rough-dried specimens. During my visit, she was engaged on a lot of algæ sent by Dr. Ferd. Müller of Australia, and, as I entered the room, she was fishing up a specimen of *Phacelocarpus Labillardieri.* In this building are kept large specimens of Ecklonia, Macrocystis, Durvillæa, etc., several feet long, mounted on very thick card-board. That is certainly the only way of getting any idea how such plants really look.

Lund lies in the large plain of Sarnia, with mountains visible in the distance. This is decidedly the most fertile part of Sweden, and the grain crop is very large. I made an excursion with Dr. Berghen to a place called Vogelsang, made classic by the visits of Linnæus. The meadows and knolls were very beautiful with centaureæ and orchids, and farther off one could see the grain fields brilliant with the usual amount of poppies, chrysanthemums, and bachelor's buttons, the characteristic "corn-weeds" of Europe.

From Lund to Stockholm is a rather long journey, particularly if one has lately been travelling in Germany. The botanists of Stockholm were all away for the vacation. So, after visiting the museum and galleries, which, although good, are not remarkable, and enjoying for a day or two this picturesque and agreeable city and its surroundings, I went on to Upsala, in the slowest train I ever saw. Upsala is not so beautifully situated, but is in most respects more interesting than Lund. The number of students is fifteen hundred, three times as great as at Lund. Many of the students are poor and are obliged to spend the vacations in Upsala, only returning home at the completion of their studies. They are divided according to the nations or provinces of Sweden, each of which has a club house, that of the Stockholm-nation being the finest. Each nation has also a lot and monument in the cemetery, and most of the students who die at Upsala are buried there, as it is a long journey to some of the provinces. In fact, Americans who judge of European distances from Great Britain and Germany are astonished at the size of Norway and Sweden. Professor Schübler of Christiania told me that it was half as far from Christiania to the northernmost point of Norway as from Christiania to Rome.

On my arrival I called at once on the venerable Professor Fries. I found him at home, surrounded by his children and grandchildren, assembled to celebrate his seventy-eighth birthday. Only one of his family was absent, a son who lives in Florida. He welcomed me warmly, and regretted that he was too feeble to show me Upsala. He spoke German, but so slowly that it was difficult to follow him. His daughters spoke English; the youngest, who is unmarried, very well. He wears the traditional long black coat and skull-cap, and has the venerable appearance and benign expression, which is shown in the photograph of himself and the amiable Madame Fries, which I remember in Professor Gray's collection. Professor Fries directed me to the college building where his son resides, and told me that he would be glad to act as my escort in Upsala. The way to the laboratory was through very classic grounds. Just back of the castle is the Library, Carolina Rediviva, with an avenue to the right leading to the Obelisk and the Cathedral. Here are some fine trees, and it has been the favorite walk of many distinguished professors. Back of the library is a large grove with a cemetery in which are buried Wahlenberg and Thunberg. In the grove and cemetery are a number of Runic monuments, and through the centre of the grove runs a broad avenue to the laboratory, in the second story of which several of the professors have suites of rooms. Not finding Professor Fries at home I called again the next morning.

The younger Professor Theodore Fries, stout and robust, and not the least like his father in personal appearance, kindly offered to be my guide in the city. The situation of Upsala is bleak and even dismal, a single hill on which stands the cathedral, castle and university buildings, in the midst of a wide plain. The cathedral, an ancient brick structure, has no great claims to beauty, but is chiefly interesting on account of the tombs and relics contained in it. The tomb of Gustav Vasa is the lion of the place, but to all naturalists the tomb of Linnæus, of black marble with a medallion, is the chief attraction. The design is simple, and in striking contrast to the elaborate sculptures sacred to the memory of some very noble but now completely forgotten individuals. In front of the cathedral is a promenade respected by the inhabitants as the favorite resort of the professors. The promenade ends at the library, the first of the university buildings, back of which, and separated from it by a grove in which are stones with curious Runic inscriptions, is a large building containing the university laboratories. Close by is the Botanical Garden, where strangers are shown Linnæus's myrtle, which is still kept alive for the purpose of supplying travellers with relics. In this way the more valuable mementoes of Linnæus are preserved from the ravages of curiosity hunters. In the hall of the herbarium building is a marble statue of the father of botany, in a sitting posture, by Byström. The expression of the face is extremely beautiful, but unfortunately not very much like Linnæus, if we are to trust the portrait at Stockholm, which was considered an excellent likeness. Professor Areschoug, best known by his algological writings, resides close to the garden. He is a rather short, thick-set man, and in his method of study is decidedly German. His collection of microscopic preparations of algæ is large, and the preparations are beautifully mounted.

Linnæus' city house, at the old Botanic Garden, is still to be seen, nearly unaltered, but it contains no relics of its distinguished owner. There are some, however, at his country house at Hammarby, five miles from town, and in the little building near it which contained his herbarium and museum. A good idea of these and of all the souvenirs of Linnæus is to be had from a series of fifteen small photographs, with an accompanying sheet of letter press, which were published a few years ago, and are still on sale. The collection was advertised at the time in most of the botanical journals, is not expensive, and could readily be obtained, I presume, by those who would be interested in these memorials. A visit to Upsala is incomplete without an excursion to the tombs of Thor, Frei and Odin, three mounds a short distance from the town. To make the scene more impressive, the Swedish urchins roll over and over down the mounds for a slight gratuity. At a restaurant near by, one is also expected to drink mead out of horns mounted with silver and inscribed with the names of princes and nobles who drank heavily from them in days of yore.

ORNITHOLOGICAL NOTES FROM THE SOUTH.

BY C. HARTE MERRIAM.

I. SOUTH CAROLINA.

THE town of Aiken is situated in the dry, sandy "Pine Barrens" of southern South Carolina. It is a great resort for invalids (especially for those suffering from pulmonary diseases), the climate being dry and healthful. It is the highest point on the Charleston railroad, having an altitude of over six hundred feet, and there are no streams or swamps in the vicinity. There is no water near excepting an exceedingly small stream which flows into a little pond two miles distant, the outlet of which empties into several larger ponds between Graniteville and Langley, five and eight miles west of the town.

The woods, which consist mainly of pine trees, abound with bright green lizards (*Anolius Carolinensis*), which, like the chameleon, possess the power of changing their color to a greenish-yellow and a dark reddish-brown. There is also another species of lizard (*Scleroporus undulatus*), which somewhat resembles the "horned toad" of our western plains; it is longer, however, and more slender and its throat and the sides of its belly are of a bright metallic greenish-blue color. Both of these species run about on old logs and rail fences and seem to take especial delight in climbing among the fragrant jessamines (*Gelsemium sempervirens*), which are very abundant in some parts of the woods. When disturbed they generally take to some tree, which they climb with astonishing rapidity; the back of the latter species so closely resembles the bark as to be scarcely distinguishable from it.

To the entomologist, Aiken may prove a more fruitful locality than to the ornithologist, since there are many bright colored and beautiful species of butterflies; but even these lose their attractions when compared with the endless varieties and curiously formed species of Coleoptera. One species of the latter in particular (*Phanæus carnifex*) reminds us of the Brazilian beetles; it is about three-quarters of an inch long, is of the brightest green color, and has a large reddish violet shield on the fore part of its back, out of which grows an immense horn that hangs over the back.

Now, after having given the readers of the NATURALIST a general idea of the locality, I will proceed to consider my more particular friends, the birds.

Arriving at Aiken on the 14th of March, I commenced collecting on the same day, and remained there three weeks, during which time one hundred and fifty-three specimens were prepared. Owing to the unusual tardiness of the season, many, and in fact most, of the spring birds had not arrived up to the time of leaving. About the 14th of March, I found the yellow-rumped warbler (*Dendrœca coronata*) very abundant: on the 17th the pine-creeping warbler (*D. pinus*) first made its appearance, after which time it was quite common; it was very appropriately named the *pine*-creeping warbler, as I never, except on one occasion, saw it alight, even for an instant, on anything but a pine tree; here it would sit by the hour and warble out its sweet song. On the 21st, I heard a delicate chirp above my head, and, looking up, saw a small bird on the top of one of the tallest pine trees; it was too high to be recognized, so I shot it, and found to my great delight that it was the yellow-throated warbler (*D. Dominica*). The black and white creeper (*Mniotilta varia*) was seen on the 18th, from which time afterwards it was common. A few Maryland yellow-throats (*Geothlypis trichas*) arrived on the 31st, but were not numerous. The hermit thrush (*Turdus Pallasii*) and the robin (*Planesticus migratorius*) were quite plentiful when I arrived. Mocking birds (*Mimus polyglottus*) did not become numerous until about the 25th, after which time they "fairly filled the air with their rich medley of inexhaustibly varied notes, the singers leaping in restless ecstasy from branch to branch, with drooping wings and spread tail, or flitting from thicket to thicket as they sang." I observed but one cat-bird (*Galeoscoptes Carolinensis*) and that was on the 4th of April; the brown thrush or long-tailed thrasher (*Harporhynchus rufus*) was very common on and after March 19th.

I shot a pewee or phœbe bird (*Sayornis fuscus*) on the 15th, after which time they were often seen. Our common kingbird, or beebird (*Tyrannus Carolinensis*) arrived on the 4th of April, when it immediately commenced its usual noisy abuse of all the other species, both large and small, especially the former. On the 22d, I shot one blue-headed vireo (*Vireo solitarius*), which was the only one seen; the white-eyed vireo (*V. Noveboracensis*), however, was quite common on and after the 27th. The great Carolina wren (*Thryothorus Ludovicianus*), though a resident, was first observed about the 27th, after which time its pleasant song was often heard. The blue-gray gnatcatchers (*Polioptila cærulea*) arrived on the 21st, and soon became very common; the ruby-crowned kinglets (*Regulus calendula*) appeared on the same day, and were equally numerous. Rough-winged swallows (*Stelgidopteryx serripennis*), in large numbers, arrived about the 22d. Hawks of all kinds were rare; one fish hawk (*Pandion Carolinensis*) was observed at Langley's Pond eight miles below here, and occasionally a *Buteo* was seen sailing above Aiken, but too high for the species to be determined. Bluebirds (*Sialia sialis*) were quite plentiful and were probably resident; they commenced nesting about the 1st of April, as did the blue jays and Carolina chickadees. I shot one loggerhead shrike (*Collurio Ludovicianus*); this species was quite rare. The common yellow bird (*Chrysomitris tristis*) was occasionally met with, and the pine finch (*C. pinus*) was very abundant. Chipping sparrows (*Spizella socialis*) were very plentiful, as were the field sparrows (*S. pusilla*), song sparrows (*Melospiza melodia*), white-throated sparrows (*Zonotrichia albicollis*), black or common snowbirds (*Junco hyemalis*), and the bay-winged bunting (*Pooecetes gramineus*).

The following is a list of the birds observed at Aiken, South Carolina, between March 14th and April 5th, 1873.

Turdus Pallasii Cab. (Hermit Thrush), abundant. 9 spns. procured.
Planesticus migratorius Linn. (Common Robin), common.
Mimus polyglottus Boie (Mocking Bird), arrived about March 25th, common. 1 spn.
Galeoscoptes Carolinensis Baird (Cat Bird), arrd. April 4, rare.
Sialia sialis Baird (Bluebird), abundant. 2 spns.
Regulus calendula Licht. (Ruby-crowned Kinglet), arrd. Mar. 21st, abundant. 6 spns.
Polioptila cærulea Sclat. (Blue-gray Gnatcatcher), arrd. March 21st, common. 4 spns.
Lophophanes bicolor Bonap. (Tufted Titmouse), very numerous. 12 spns.
Parus Carolinensis Aud. (Carolina Chickadee), common. 4 spns.
Sitta Carolinensis Gmelin (White-bellied Nuthatch), not common. 2 spns.
Sitta pusilla Latham (Brown-headed Nuthatch), rare. 2 spns.
Certhia Americana Bonap. (Brown Creeper), rather common. 2 spns.
Thryothorus Ludovicianus Bonap. (Gt. Carolina Wren), not common. 2 spns.
Geothlypis trichas Cab. (Maryland Yellow-throat), not common. 1 spn.
Dendrœca coronata Gray (Yellow-rumped Warbler), very common. 8 spns.
Dendrœca pinus Baird (Pine-creeping Warbler), arrd. March 17, common. 18 spns.
Dendrœca Dominica Baird (Yellow-throated Warbler), March 21st, rare. 1 spn.
Stelgidopteryx serripennis Baird (Rough-winged Swallow), arrd. March 22, common. 2 spns.
Vireo Noveboracensis Bonap. (White-eyed Vireo), arrd. March 27, very common. 3 spns.
Vireo solitarius Vieill. (Blue-headed Vireo), arrd. March 22, rare. 1 spn.
Collurio Ludovicianus Baird (Loggerhead Shrike). rare. 1 spn.
Chrysomitris tristis Bonap. (Yellowbird), not common. 2 spns.

Chrysomitris pinus Bonap. (Pine Finch), very abundant. 9 spns.
Poccetes gramineus Baird (Bay-winged Finch), common. 3 spns.
Zonotrichia albicollis Bonap. (White-throated Sparrow), abundant. 6 spns.
Junco hyemalis Sclat. (Snowbird), common. 2 spns.
Spizella pusilla Bonap. (Field Sparrow), common. 2 spns.
Spizella socialis Bonap. (Chipping Sparrow), common. 2 spns.
Melospiza melodia Baird (Song Sparrow), common. 2 spns.
Melospiza palustris Baird (Swamp Sparrow), rather common. 1 spn.
Cardinalis Virginianus Bonap. (Redbird), common. 6 spns.
Pipilo erythrophthalmus Vieill. (Chewink), common. 3 spns.
Agelæus phœniceus Vieill. (Red-winged Blackbird), not common. 1 spn.
Sturnella magna Sw. (Meadow Lark), not common.
Cyanura cristata Sw. (Blue Jay), common. 4 spns.
Corvus ossifragus Wilson (Fish Crow), not common.
Tyrannus Carolinensis Baird (King Bird), arrd. April 4, common. 1 spn.
Sayornis fuscus Baird (Pewee), common. 5 spns.
Ceryle alcyon Boie (Belted Kingfisher), rare.
Picus villosus Linn. (Hairy Woodpecker), rare. 1 spn.
Picus borealis Vieill. (Red-cockaded Woodpecker), rare. 1 spn.
Sphyropicus varius Baird (Yellow-bellied Woodpecker), common. 4 spns.
Melanerpes erythrocephalus Sw. (Yellow-bellied Woodpecker), not common. 1 spn.
Colaptes auratus Sw. (Yellow-shafted Flicker), common. 2 spns.
Hypotriorchis columbarius Gray (Pigeon Hawk), rare. 1 spn.
Tinnunculus sparverius Vieill. (Sparrow Hawk), not common. 1 spn.
Cathartes aura Illig. (Turkey Buzzard), common. 1 spn.
Cathartes atratus Lesson (Black Vulture), not common.
Zenædura Carolinensis Bonap. (Common Dove), common. 2 spns.
Ortyx Virginianus Bonap. (Common Quail), abundant. 1 spn.
Butorides virescens Bonap. (Green Heron), not common. 1 spn.
Ægialitis vociferus Cassin (Kildeer), not common.
Philohela minor Gray (American Woodcock), rare.
Tringoides macularius Gray (Spotted Sandpiper), not common.

BOTANICAL OBSERVATIONS IN WESTERN WYOMING.

BY DR. C. C. PARRY.

No. 1.

Having been connected with the exploring expedition of Captain W. A. Jones into Northwestern Wyoming during the past season (1873), the botanical results have proved of such unexpected interest that I have obtained the permission of Captain Jones to anticipate the more detailed official report by preparing for immediate publication a brief sketch of the general botanical features of the region passed over, with notices of rare plants and descriptions of new species collected on the route.

Fort Bridger to Camp Brown. Leaving the point of rendezvous at Fort Bridger on the 12th of June, our route followed a northeasterly course over Green River basin, thence skirting along the southern spurs of the Wind River range. The main continental divide was crossed at South Pass. From this point following a more direct northerly course we reached Camp Brown in the Wind River valley on July 1st.

The chief botanical interest on this portion of our route was comprised in the many suggestive associations with the early discoveries of Nuttall nearly forty years previous. Though this route has been repeatedly traversed by exploring parties, lying in fact on the well-beaten track of western emigrant travel previous to the construction of the Pacific Railroad, not a few of the plants then collected and described have remained up to this time *desiderata* in herbaria.

Unusually copious spring rains previous to our journey had freshened the vegetation of these usually arid tracts, so that our necessarily slow and tedious marches, encumbered by a heavily laden wagon train, were enlivened (at least to the botanist) by unwonted verdure. Even the repulsive "sage plains" and "grease wood" flats, so monotonous and forbidding to the ordinary traveller, yielded up unexpected treasures of rare plants. Among these the evanescent annuals were in great profusion, including *Cleome aurea* Hook., *Calyptridium roseum* S. Watson, *Œnothera Andina* Nutt., *Œnothera scapoidea* Nutt., *Astragalus Geyeri* Gray, *Astragalus pictus* Gray, *Chœnactis Douglasii* H. & A., *Plantago Patagonica* Jacq., *Gilia inconspicua* Dougl., and *Oxytheca dendroidea* Nutt. In the moist grassy valley of Little Sandy were also found quite abundantly *Capsella divaricata* Walp. and *Gentiana humilis* Stev., heretofore overlooked by collectors in this region.

Of perennial plants, serving somewhat to relieve the prevalent and monotonous growth of *Artemisia*, *Tetradymia* and *Linosyris*, comprising what is popularly known as "wild sage," and the equally forbidding Chenopodiaceous shrubs confounded under the common term of "grease-wood," may be noted several species of *Astragalus* including *A. Purshii* Dougl., *A. lotiflorus* Hook, *A. glareosus* Dougl., *A. junceus* Nutt., and now collected for the first time since Nuttall's original discovery, *A. pubentissimus* Nutt. and *A. flavus* Nutt., the former a not uncommon roadside plant, and the latter quite abundant along the margins of dry watercourses, at the foot of steep clay buttes.

On gravelly knolls adjoining Green River still another interesting Nuttallian plant was rediscovered, *Tanacetum Nuttallii* Torr. & Gray, and growing in close proximity with this was found *Vesicaria Alpina* Nutt., both probably near the original station of Nuttall.

Nearly everywhere over this district in exposed situations we meet with *Eriogonum ovalifolium* Nutt., forming dense silvery cushions, its close globular heads of flowers exhibiting a great variety of tints from pure white to dark brown. Almost equally abundant on gravelly slopes also occur *Aplopappus acaulis* Gray, and *Astragalus simplicifolius* Gray, presenting a neat contrast of colors in their bright yellow and blue flowers, resting in mats of dark green and silvery foliage.

Quite constantly associated in growth with *Astragalus flavus* Nutt. is a showy asteroid plant with large white flowers, disposed in flattened summits surmounting the dull colored tomentose leaves. This plant, according to Dr. Gray, is closely allied to or perhaps identical with the *Xylorhiza villosa* Nutt. (*Aster Xylorhiza* Torr. & Gray). In view of the discrepancy in many respects between this plant and that described by Nuttall, Dr. Gray has thought proper to characterize it as a new species, *Aster Parryi*.

Among other plants worthy of note in this district may be enumerated *Delphinium Menziesii* DC., *Sisymbrium junceum* Bieb., *Viola Nuttallii* Pursh, *Cymopterus montanus* Nutt., *Cymopterus Fendleri* Gray, *Antennaria dimorpha* Nutt., *Artemisia pedatifida* Nutt., *Phlox longifolia* Nutt., *Phlox canescens* Torr. & Gray, *Castilleia parviflora* Bong., *Pentstemon humilis* Nutt., and *Gilia pungens* Benth.

On reaching the higher ground forming the eastern rim of the Green River basin, which leads by an easy pass, at an average elevation of seven thousand feet above the sea level, from the Pacific to the Atlantic slope, the prevalent desert growth gives place to a vegetation partaking of a sub-alpine character. This district comprises the botanical localities designated by Nuttall as "dry and lofty hills in the central range of the Rocky Mountains."

Here accordingly we again come within the range of these early discoveries in re-collecting such choice plants as *Draba Alpina* L., var. *densifolia*, *Lepidium montanum* Nutt., *Trifolium Andinum* Nutt., *Trifolium gymnocarpon* Nutt., *Astragalus campestris* Gray, *Oxytropis lagopus* Nutt., and *Phlox bryoides* Nutt.

Here also we meet for the first time, probably near its southeastern limits, the interesting *Lewisia rediviva* Pursh. This becomes much more abundant farther north in the Wind River valley, and we were thus afforded an opportunity to observe this plant through its flowering and fruiting stages, extending from the latter part of June to the middle of July. After this latter period its matured capsules are detached and blown away, leaving no trace of the plant exposed to view, till the following spring develops the rosette of radical leaves, by which the Indians are guided in procuring their supplies of this palatable and nutritious root. Recent attempts have been made to introduce this showy plant into our gardens, where it would prove quite an acquisition.

Shrubbery is here represented mainly by *Rosaceæ*, including *Amelanchier Canadensis* Torr. & Gray, *Potentilla fruticosa* L., *Purshii tridentata* DC., *Ribes cereum* Dougl., but we look in vain, in apparently favorable localities, for the forms so well known in the mountain range farther south in Colorado of *Ribes deliciosus* Torr., *Cercocarpus parvifolius* Nutt., or *Jamesia Americana* Torr. & Gray.

The scanty pine growth includes chiefly *Pinus flexilis* James, with an occasional clump of *Abies Douglasii* Lindl., and *Juniperus Virginiana* L.

The southeastern spurs of the Wind River range present a succession of steep, grassy slopes agreeably interspersed with pine-clad ridges. Through numberless channels the mountain streams collect their summer tribute of melted snow, and cleave their way to the lower valleys through deep gorges, disclosing in steep mural faces the structure and succession of the underlying, highly inclined, rocky strata. The lower undulating slopes, forming the natural divides between the numerous watercourses tributary to the main valley of Wind River, form irregular ridges often presenting smooth tabled summits, bedded with rich grasses interspersed with gaily colored flowers. Conspicuous among the latter are the bright golden-yellow heads of *Balsamorhiza Hookeri* Nutt., and *Balsamorhiza sagittata* Nutt., growing promiscuously, the close similarity of their flowers being curiously contrasted with their diverse foliage; even in the latter case, however, a tendency to assimilate (perhaps due to hybridization) is occasionally observed, in which the sharply hastate leaves of the latter species are irregularly gashed to resemble forms of the other. Besides these everywhere obtrusive forms, we may also note as characteristic of this district *Geranium Fremontii* Torr., *Arenaria congesta* Nutt., *Arenaria Hookeri* Nutt., *Astragalus campestris* Gray, *Oxy-*

tropis campestris L., *Lupinus sericeus* Pursh, *Hedysarum Mackenzii* Rich., *Eriogonum flavum* Nutt., and *Calochortus Gunnisoni* Watson. On all the high rocky ridges of this section a charming variety of *Phlox Douglasii* Hook. is met with, forming close, flattened cushions, and a profusion of pure porcelain-white fragrant flowers.

Along the borders of streams, with the prevalent willow growth, we find *Betula occidentalis* Hook., *Alnus incana* Willd., and in the larger valleys *Elæagnus argenteus* Nutt.

On the steeper mountain slopes, before alluded to as presenting an agreeable alternation of meadow and woodland, the smooth grassy expanses of the higher elevations, reaching an altitude of nine thousand feet above the sea level, reveal a distinctly subalpine vegetation. We accordingly here encounter such well known forms as *Saxifraga nivalis* L., *Eritrichium aretioides* DC., *Polemonium confertum* Gray, *Lloydia serotina* Reich., while apparently more distinctly characteristic of this particular range we note *Townsendia spathulata* Nutt., *Townsendia scapigera* D. C. Eaton and *Bupleurum ranunculoides* L.

In the wooded districts *Pinus flexilis* is irregularly mingled with *Pinus ponderosa* and *Abies Douglasii*, while *Pinus contorta* forms the almost exclusive growth of the interior ridges and alpine valleys. After passing the first series of steep ridges, which generally present an abrupt escarpment towards the main axis of the range, the interior valleys are spread out in the form of irregular basins, bordered by deep pine woods. Within these timbered recesses we occasionally encounter small grassy parks, or alpine bogs occupied by a close, clumpy growth of willows. Through these, course clear mountain streams generally hidden from view by overhanging vegetation. During the season of melting snow in the early summer months, these meadows frequently conceal treacherous bogs greatly impeding travel, while small ponds and occasional permanent lakes are not infrequent. In this variety of surface exposure, limited in every direction by irregular, rocky ridges, variously set off with extensive snow drifts, we have all the conditions of a most attractive mountain flora.

We accordingly find here in somewhat confused association the following plants:—*Draba Alpina* L., *Lupinus cæspitosus* Nutt., *Hedysarum boreale* Nutt., *Astragalus Alpinus* L., *Oxytropis campestris* L., *Oxytropis viscida* Nutt.? (or a species near it), *Sedum stenopetalum* Ph., *Sedum rhodanthum* Gray, *Actinella grandiflora*

T. & G., *Antennaria dioica* L., *Senecio lugens* Rich., *Kalmia glauca* L., *Synthyris plantaginea* Benth., *Mertensia paniculata* Dougl., *Gilia nudicaulis* Gray, *Androsace septentrionalis* L., *Primula Parryi* Gray, *Gentiana humilis* Stev., *Phacelia sericea* Gray.

In succeeding articles the flora of the Owl Creek range and of the high mountain district between the Big-Horn and Yellowstone basins will be noticed.

ANIMAL LIFE OF THE CUYAMACA MOUNTAINS.

BY DR. J. G. COOPER.

WHEN collecting at San Diego Bay in the spring of 1862, I much regretted that the severe floods of that noted season so broke up the roads into the mountains, that I could not get up to them with the necessary materials for making a full collection of the animals and plants. I then supposed that the greater moisture and large forests of the mountains would favor the existence of numerous species as yet uncollected within the Union, if not entirely new. I was disappointed in not finding more of them near the coast, and attributed their absence to the barrenness of the country, and want of trees, essential to many species. I supposed also that some of the Mexican or Lower Californian species said to be found near the boundary must exist there.

My late trip through the mountains, has, however, satisfied me that the animals, like the plants, are comparatively few in species, and mostly of northern forms. It is possible that, somewhat later, stragglers from Lower California might appear among birds and insects, but I was then so near the end of the spring migration, in this latitude, that no common visitors are likely to have escaped notice. As to the non-migratory animals, they have evidently been rendered very scarce by the want of water over most of the range, even in early spring and in an average rainy year like the past. Those that drink could find water in the fall only at intervals of ten to twenty miles, where they must fall an easy prey to the Indians who live at these localities.

The birds, reptiles, insects and mollusca, are however less dependent on a water supply than mammals, as the former can obtain enough from rain and fogs, while the lower classes frequently remain torpid during unusual droughts.*

The mammals seen were very few. The grizzly bear (or perhaps a different species called the cinnamon bear) is said to occur rarely. The skunks, the most frequently noticed of the small carnivora, did not make their presence known, and I heard ten years ago, that the dry seasons preceding had nearly exterminated them in the low country. The other small carnivora are still more scarce, their usual prey, the Rodentia, having disappeared.

Wild cats are not rare about the highest peaks, and a skin I saw was only a young of the common *Lynx rufus*, var. *maculatus.* I heard formerly of long-tailed spotted cats being found in these southern ranges, but if the *Felis eyra* or *Felis onza* have ever reached them by crossing the deserts eastward, they have become now exceedingly scarce, through starvation or from being hunted. Cayotés (*Canis latrans*) are scarce, and I heard nothing of foxes.

Of Rodents, the almost universal *Spermophilus Beecheyi* was so scarce in the mountains, that I saw only two, both near streams at four thousand feet altitude. They are, however, common near river-beds along the coast, though less so than formerly. I saw a small spermophile near Julian which may have been *S. lateralis*, or a new species, obtained by me at Fort Mojave.

The largest of our tree squirrels, found on the San Bernardino range (*Sciurus leporinus*), is absent, as well as all its arboreal allies. I saw none of the numerous and destructive murine burrowers, nor any bats, but a longer residence might furnish these in some spots. Of the Hare family I saw only a few; *Lepus Californicus* in the foot-hills, and *L. Audubonii* once about two thousand feet up.†

Deer, requiring much water, are very scarce, while the mountains are too rough for the antelope, and too much wooded for the mountain sheep, though both of these may occur not far away.

On account of the scarcity of carnivorous animals, certain kinds of small and prolific species become very abundant after one or two rainy years. Hares and rabbits may then be seen by hundreds at a time, and the California quail as well as other resident birds show the same rapid increase in such years, when food is abundant. Two very dry years preceded this, and consequently all these animals had become quite scarce.*

---

* The complete drying up of the streams from this range, at times, is shown by the absence of fish. Trout and sticklebacks are found no nearer than Warner's Pass fifteen miles north of San Felipe at the head of San Luis Rey river.

† The finding of *Lagomys princeps*, the "Little Chief Hare," by Mr. Gabb, on a mountain in Lower California ten thousand feet high and near the boundary line, is a problem in zoology not easily solved, as this animal could not have reached there from the north under the present climatic conditions, since it does not come lower down on the Sierra Nevada in latitude 39° than six thousand feet (see Proceedings of the Academy of Natural Sciences, Philadelphia, 1868).

Birds.—Of these I give a list, with such notes as seem requisite. [Those marked † were not found by me in the lower country from January to May, 1862.] Turkey buzzard (*Cathartes aura*), chiefly seen near base of mountains; prairie falcon (*F. polyagrus*), seen once or twice; sparrow hawk (*Tinnunculus sparverius*), quite common; sharp-shinned hawk (*Accipiter fuscus*), not rare; brown hawk (*Buteo insignatus*), very common from the base to the mines, 4,500 feet altitude, and always prized, but I did not find any nests nor shoot a specimen. It seems to be the form most characteristic of this region, though the western red-tail (*B. montanus*) is also common. None of *B. Swainsonii* seen. Squirrel hawk (*Archibuteo ferrugineus*) chiefly near the open plains; marsh hawk (*Circus Hudsonius*), at almost every meadow or low plain.

† Golden eagle (*Aquila Canadensis*), seen rarely; great horned owl (*Bubo Virginianus*), seen or heard on all parts of the route where any trees exist; burrowing owl (*Athene cunicularia*), not found much above the foot-hills.

† Harris' woodpecker (*Picus Harrisii*), a common species in the forests high up; California woodpecker (*Melanerpes formicivorus*), very common, probably up to the highest summits, but not down to the mésa, chiefly in the oaks.

† Lewis' woodpecker (*M. torquatus*), not uncommon in the higher mountains; red shafted flicker (*Colaptes Mexicanus*), abundant almost everywhere; rufous humming-bird (*Selasphorus rufus*), observed April 28th, at 3,800 feet altitude, where they probably breed. Anna humming-bird (*Calypte Anna*), quite common along the route. There were perhaps other species but I did not identify them.

† Oregon swift (*Chætura Vauxii*) seen at the old mission, migrating northward, April 26th, and may perhaps summer in the mountains. [The rare white-throated swift (*Panyptila melanoleuca*) breeds in the Santa Anna mountains, fifty miles north, and perhaps in these.]

† Poor Will (*Antrostomus Nuttallii*), heard at Cajon valley. I both heard and saw these birds near San Francisco as early as March 20th. Arkansas and Cassin's kingbirds (*Tyrannus verticalis* and *T. vociferans*), the last only near the foot-hills, or below. Ash-throated flycatcher (*Myiarchus Mexicanus*), not rare up to 4,000 feet altitude; black pewee (*Sayornis nigricans*), chiefly about the foot-hills.

† Little flycatcher (*Empidonax pusillus*), and probably other species migrating, but not numerous up to 4,500 feet altitude; dwarf thrush (*Turdus nanus*), common in thickets; robin (*T. migratorius*), common near the high forests and no doubt resident; western bluebird (*Sialia Mexicana*), abundant throughout the forests; yellow-throat (*Geothlypis trichas*), common about moist thickets.

† Macgillivray's warbler (*G. Macgillivrayi*), not so common, and in drier localities; orange-crowned warbler (*Helminthophaga celata*), abundant in the lower parts.

† Western warbler (*Dendrœca occidentalis*), very common between 1,500 and 4,500 feet altitude, and probably remains all summer. This is the first time I have seen this species common, and it seems to be rare elsewhere, though found in May at the Columbia river, and as early as April 1st, at Petaluma, California, latitude 38°. Large numbers of this and the next four species were seen in the oak forests on both slopes, and though still gregarious were singing a little, and doubtless build there. The others were Townsend's, the gray, Audubon's and the summer warblers (*D. Townsendii, nigrescens, Audubonii, æstiva*); Audubon's probably builds only in the highest woods, as it does at 6.000 to 7,000 feet in latitude 39°; black-capped warbler (*Myiodioctes pusillus*),

---

* Compare the list of animals of the "Southern Coast Slope" in this journal, June, 1869, and Proceedings California Academy Science, v, Feb., 1870.

quite common and up to summits; Louisiana tanager (*Pyranga Ludoviciana*), abundant on higher part of mountains, and down to foot-hills in summer; cliff swallow (*Hirundo lunifrons*), the only kind found everywhere, except on the high parts above 3,500 feet.

† Green swallow (*H. thalassina*), common in the oak groves up to 4,500 feet; martin (*Progne purpurea*), not uncommon; shining flycatcher (*Phænopepla nitens*), seen rarely among mistletoe in foot-hills; Hutton's greenlet (*Vireo Huttoni*), not rare on the lower mountains; little vireo (*V. pusillus*), common in willow thickets along the lower part of rivers. † Solitary vireo (*V. solitarius*), not rare, and resident; mocking bird (*Mimus polyglottus*), not seen above the edges of the mésa. [The mountain mocking bird (*Oreoscoptes montanus*) has been found "near San Diego."] Bow-billed thrush (*Harporhynchus redivivus*), common in the lower region.

† White-throated wren (*Catherpes Mexicanus*), seen and heard only near Cajon valley, among immense granite bowlders. Their cry sounds like shrill ringing laughter. Bewick's wren (*Thryothorus Bewickii*), common in the lower country; wren-titmouse (*Chamæa fasciata*), very common on the shrubby hillsides; slender-billed nuthatch (*Sitta aculeata*), common chiefly on the east slope in pine woods. † California nuthatch (*S. pygmæa*), also common among pines high up; gray titmouse (*Lophophanes inornatus*); not rare throughout the oak forests; mountain titmouse (*Parus montanus?*), very common indeed near the pine forests. It is possible that this may prove a new species, as they looked smaller and differently marked, but I did not succeed in getting any. Other "critical" species may yet be found to represent some of the northern birds here named. Least titmouse (*Psaltriparus minimus*), common at least half-way up mountains; horned lark (*Eremophila cornuta*), abundant on open plains everywhere. I saw fledged young at San Diego, May 3.

† Evening grosbeak (*Hesperiphona vespertina?*), or some similar bird, I saw and heard a few times near the summits of the mountains; lark finch (*Chondestes grammaca*) is common on most open plains up to 3,000 feet altitude; Bell's finch (*Poospiza Belli*) is confined to the low mésa and foot-hills; chipping sparrow (*Spizella socialis*) common on most parts up to 4,000 feet; Heermann's song sparrow (*Melospiza Heermanni*), also common; black-headed grosbeak (*Guiraca melanocephala*), very common in all the woods.

† Blue grosbeak (*Guiraca cærulea*) also quite common up to 4,500 feet. [Going north I saw twenty-five miles north of San Diego, a single Mexican goldfinch (*Chrysomitris Mexicanus*), new to the California fauna.] Blue (or lazuli) finch (*Cyanospiza amœna*), numerous in the foot-hills, up to 3,500 feet; California ground robin (*Pipilo megalonyx*) has about the same range; brown finch (*Pipilo fuscus*) does not go as high up.

† Cow bird (*Molothrus pecoris*) occurred in flocks on the east side of summit only, at 4,500 feet altitude; yellow-headed blackbird (*Xanthocephalus icterocephalus*), with the last, and also on west slopes in marshes; western lark (*Sturnella neglecta*), everywhere in open plains and meadows; Bullock's oriole (*Icterus Bullockii*), common; hooded oriole (*I. cucullatus*), not rare up to 2,000 feet in foot-hills; Brewer's blackbird (*Scolecophagus cyanocephalus*), abundant almost everywhere; raven (*Corvus carnivorus*), in pairs occasionally up to at least 4,500 feet; western crow (*C. caurinus*), common up to about 2,000 feet in oak woods.

† Clarke's crow (*Picicorvus Columbianus?*) probably occurs, as almost always in the yellow pine forests, but at this season is so shy and silent that I am not certain of having seen it.

† Steller's jay (*Cyanura Stelleri*) was not rare in the pine woods. California jay (*Cyanocitta Californica*), confined to the oak woods up to about four thousand feet altitude.

† Band-tailed pigeon (*Columba fasciata*), in small flocks above three thousand feet altitude.

† Mountain quail (*Oreortyx pictus*) is common above three thousand five hundred feet, and were paired by April 28th. I afterwards heard what I think was this bird on a mountain east of Anaheim, Los Angeles Co., at not over one thousand feet elevation, where some small cypress trees grow. A male shot agrees exactly with description

except in size smaller than northward. This is one hundred and twenty miles south of the most southern locality before known.

California quail (*Lophortyx Californicus*), confined to the region below three thousand five hundred feet.

Snowy heron (*Garzetta candidissima*), I saw once at a pond on east side, four thousand five hundred feet. Kildeer (*Ægialitis vociferus*), common about every gravelly stream or pond.

† Stilt (*Himantopus nigricollis*), probably migrating April 30th, when I saw a flock of about twenty at the same locality as last.

† Solitary sandpiper (*Rhyacophilus solitarius*) occurred rarely along wooded streams high in the mountains. Coot (*Fulica Americana*), rare on pools high up in the mountains. Mallard (*Anas boschas*), in small flocks on the ponds and head waters of San Diego river at four thousand five hundred feet altitude, where they no doubt remain all summer.

Thus, of eighty-four species observed, only seventeen are new to the country, and all these are species of much more northern range. Three or four belong rather to the mésas than the mountains, with others not mentioned. During my former six months' residence I found twenty other species of land birds alone, within ten miles of the coast; some, however, only winter visitors there. I saw also twenty-six other waders, and fifty-two swimmers.

REPTILES.— I noticed none above the mésa, perhaps on account of the early season, though it was warm enough up to four thousand feet on our return route. Many little wood-frogs (*Hyla regilla*) were about the high marshes, and I heard what I supposed to be salamanders piping with them at night.

FISHES.— None are known to exist in this range.

MOLLUSCA.— At the cañon of San Diego river is a rich locality for terrestrial species, as I found there the meeting point of the five largest species belonging to the mésa and the mountains, associated in considerable numbers, but difficult to obtain living, as they had mostly retired into deep fissures of the rocks. My rapid journey was not favorable for obtaining many species, but they have been collected by Mr. H. Hemphill, at the mines, also by Mr. Hemphill, Mr. G. W. Dunn and myself near San Diego (in 1862), so that I can give the following lists, comparing the species of the two regions. We saw no trace of the Lower Californian Bulimuli, etc.

LOWLAND SPECIES.

1. Lysinoe Carpenteri.
3. Arionta? Kellettii.
5. Macrocyclis Voyana.
7. "Helix" Newberryana (Limax campestris, I found at San Juan R., 50 miles northward, and it very probably occurs nearer to San Diego Bay).
12. Planorbis subcrenatus.
12. Succinea rusticana.
14. Limnophysa bulimoides.
16. Physa Gabbii.
18. Physa humerosa, *var.* virgata. (Not on Mts.?)

5. For notes on this and others, see Proc. Cal. Acad. v, 171, June, 1871.
7. This inhabits a belt in the foothills not over 500 ft. elevation, and at the upper edge of Mesa.
18. Found about Desert with Helisoma ammon.

MOUNTAIN SPECIES.

2. Lysinoe Traskii.
4. Arionta tudiculata.
6. M. Vancouverensis ?H. Newberryana.
8. Hyalina arborea.
9. Conulus chersina.
10. Pseudohyalina Mazatlanica.
11. Vallonia minuta.
13. Succinea Oregonensis.
15. Lymnophysa humilis.
17. Physa diaphana.
19. Pisidium occidentale.

2. Young, of 2-3 wh. hirsute.
4. Up to 1,000 ft. elevation.
6. I found this dead only, and think it may be distinct from the far northern species. Only seen in the Canon.

ON THE RELATIONSHIP BETWEEN DEVELOPMENT AND THE SEXUAL CONDITION IN PLANTS.

BY JOHN STOCKTON-HOUGH, M. D.

INDIAN CORN (*Zea Mays*) is sexually monœcious, that is, the male and female flowers are normally on different parts of the same plant. Occasionally, however, the female flowers appear among the male flowers, on the same raceme, and more rarely, the male flowers appear on the spike (ear) among the female flowers, and still more rarely, they are hermaphroditic.

Other observers reverse the order of rarity of these anomalies and say that "male flowers sometimes appear amongst the female flowers, and Mr. J. Scott has lately observed the rarer case of female flowers on a true male panicle, and likewise hermaphrodite flowers."*

The writer collected and examined nearly a hundred specimens of these anomalies (female flowers among the males), during the last autumn (1872) with a view of determining the relationship between the *proportion* or excess of either *sexual element* and the condition of *development* of the *plants* bearing such anomalous flowers.

The stalks bearing female flowers among the males were almost without exception "*suckers*," that is, branches coming off from the main stalks at the nodes among the adventitious roots just below the surface of the ground. The junction of one of these "suckers" with the stalk on which it is a parasite, so to speak, is greatly constricted, and the point of attachment is scarcely more than an eighth of an inch across. There are few, if any, serviceable adventitious roots to these suckers, so the stalk derives its nourishment wholly from the trunk to which it is joined, and as a consequence such stalks are short, slim and pale in color, having abridged internodes, or in other words, *they are undeveloped.* A wet season, injury to the main stalk, shady locations and the borders of fields, seem to favor their production.

---

*Darwin, Variations in Animals and Plants under Domestication, out of Trans. of Botan. Soc. of Edinburgh, vol. viii, p. 60.

From what has been brought forward, it would appear as if these sexual anomalies were the result of *deficient nutrition*, from which resulted *defective development* and *restrained evolution* of the sexual organs.

There were many stalks to be found, bearing male flowers ("tassels") alone in the normal position (terminal), apparently perfect males in size and development, but no stalks are to be found bearing a complete spike (ear) of perfect female flowers alone, even when terminal. Such spikes (ears) are always defective, often being but partially filled with grains, even when no male flowers are present.

The spike (ear) is only an undeveloped branch, sometimes having two or three internodes it is true, but it is generally sessile.

When the ear is in the normal position, no matter how much the female flowers may prevail or how defective they are, the male flower always normally appears in the terminal part of the main stem or stalk. Not so with the wholly male plant, which has a tassel in the normal position (terminal) without a sign of a place for a female flower.

When the ear (female spike) abnormally bears male flowers, they are usually terminal on the cob, though sometimes they may be on any other part of the ear, even a single male flower among the closely crowded grains (females). Mr. Scott, as already mentioned, speaks of having found even hermaphrodite flowers, which would naturally appear to be much more rare among diœcious plants than among the monœcious, for the latter condition would appear to stand between the diœcious and the hermaphroditic.

Great numbers of corn plants bear male flowers only, while none are female alone, and wherever they approach the latter condition, the spike (ear) of female flowers is terminal. These exclusively male plants are usually as large as if not indeed larger than the normal kind (monœcious) and are certainly more rank and vigorous in their growth than those plants which bear principally female flowers on the terminal part of the plant, which latter, as I have already said, are much shorter, more slender, and pale in color.

The following table will indicate these differences. Fifty specimens of plants of Indian corn, having an abnormal sexual arrangement of the flowers, had the following proportions:—

	Exclusively male stalks (diœcious).	Normal stalks, male and female (monœcious).	Stalks having a few female flowers in the male panicle (approaching hermaphroditism).	Stalks having nearly all the flowers female and terminal (nearly diœcious).
Average height.	124 in.	118 inches.	88 inches.	46 inches.
Terminal internodes.	7-11 in.	6-10 "	4-6 "	½-2½ "

From this showing it appears that in proportion to the participation or predominance of the female element, just in that proportion does the plant decline in size and development, and we are forced to conclude, as we have shown in several other articles,* that *females are undeveloped males*, and this is true in plants as well as among animals.

In some cases where the female flowers were on the male panicle, instead of forming a single large ear, as was usually the case, each branch of the panicle bore grains separately, which must have resembled what Bonafous mentions as a variety called Cymosa, which has its ears so crowded together that it is often called *maïs à bouquet.* Some of the specimens examined by me had the appearance as if the cob had been separated into several segments, triangular in shape, bearing corn only on one side (the outer) of the triangle.

Returning to those stalks bearing male flowers alone and which, I have said, are tallest, most rank, and best developed,—I would suggest that the absence of female flowers was due to retarded fecundation of the ovules from which such stalks were produced. This point might be practically tested by planting a single stalk in a field far removed from any other corn. The tassel should be cut off as often as required to prevent the male flowers from forming, then the pollen from another plant should be applied to the female flower at the latest moment when fecundation is possible. By this method we should expect to get the largest possible proportion of exclusively male-generating grains. To get the largest possible proportion of female-producing grains, the female flower should be fecundated at the earliest possible moment—earlier than nature does it. The grains produced under these circumstances would, when planted, give the largest and the smallest proportion of exclusively male or female plants.

---

* Longevity and other biostatic peculiarities of the Jewish race. N. Y. Medical Record, May 15, 1873. pp. 241, 2, 3, 4. The Relative Viability of the Sexes, etc. N. Y. Medical Record, June 16 and July 15. 1873. pp. 9. The Laws of Transmission of Resemblance from Parents to their Children. N. Y. Medical Record, Aug. 15, Sept. 15, Oct. 15, and Nov. 15, 1873. pp. 16. Statistics Relating to Births, Marriages and Deaths, and Movement of Population in Philadelphia, for the eleven years ending 1871. Penn. Monthly, Sept., 1873. pp. 24. Papers of the Social Sci. Assoc. of Philadelphia, 1873. The Physical Aspects of Primogeniture. N. Y. Medical Record, Jan. 15, and Feb. 15, 1874. The Temperature of the Sexes, an Indication of Development. Phil. Times. Nov. 8th, 1873. pp. iii. Nativity of Parents, as Influencing the Fecundity and Proportion of Sexes in births in general, and in twin, illegitimate, and still-births in particular, Phil. Med. Times, 1873. A new Theory as to the Cause of Enlargement of the Prostate Gland, etc. The Proximate Cause of Evolution.

An Inaugural Dissertation [presented to the Trustees and Faculty of the University of Pennsylvania, March 13, 1868, for the Degree of Doctor of Medicine], entitled; Prepotency, Sexual Elective Affinity, Non-congeniality, or the *dynamic differentiation* of the Elements of Reproduction in the Human Species; the cause of Relative Sterility; By John Stockton-Hough, A. M., M. Chem., of New Jersey; The Cause of Rotation and a nearly equal number of Sexes in Births."

It would be well to determine whether the grains near the tip, in the middle, or near the base of the ear, gave the largest proportion of exclusively male-producing grains. The following will illustrate how the facts might be tabulated:—

Grains.	Number of stalks no ear.	Stalks one ear.	Stalks two ears.	Whole number of ears.	Whole number of stalks.	Average number of ears to each stalk.
From tip	X	P	V	P+2V	X+P+V	$\frac{P+2V}{X+P+V}$
From middle	Y	T	W	T+2W	Y+T+W	$\frac{T+2W}{Y+T+W}$
From base	Z	N	O	N+2O	Z+N+O	$\frac{N+2O}{Z+N+O}$

Metzger* has observed that the effect of climate on Indian corn, as cultivated in Germany, causes "the lower seeds in the ear to keep to their proper form, but the upper seeds become slightly changed."

"Among species of Carex, it is a common thing for the spike to consist of male flowers at the top, and female flowers at the base; though the converse is much more common."† Dickson, Mohl, Schleiden, Braun, Cranmer and others have observed cones of different species of pines, usually female, having male flowers in the lower part of the cone.

M. Charles Girou de Buzareignues‡ has made many observations on the proportion of male and female plants produced from seeds taken from different parts of the hemp plant. He found that the seed taken from the lower, more mature, and more highly developed parts of the plant gave a much larger proportion of male-producing seed, than seed taken from the upper, more succulent, less mature, less highly developed parts, as the following figures will indicate. Of 125 hemp plants the proportion of males to females was—

---

* Getreidearten, s. 206.

†Annales des Sciences Naturelles, t. xvi, p. 140, extracted from his De la Génération, 8vo, Paris, 1828.

‡ Maxwell Masters; Vegetable Teratology, Ray Soc., London, 1869. 8vo, pp. 191 (Heterogamy); compare Hopkins' General View of the Anomalies in the Vegetable Kingdom, Glasgow, 1817, also, Moquin-Tandon; Éléments de Teratologie Végétal, 1841, p. 126, *et al.*

	Males	Females
1° In the subjects taken from the weak plants,..........	692	1000
In those which came from strong plants,..............	907	1000
2° In the subjects taken from the seeds furnished by the *inferior half* of the stem of weak plants,............	1250	1000
And in those which came from the *superior half*......	444	1000
3° In the subjects taken from the seed furnished by the *inferior half* of the stem of strong plants,...........	1000	1000
And in those which came from the *superior half*,......	827	1000

The same observer in subsequent experiments[*] declares that seeds from nearest the summit of the stem gave proportionally more females than those from the middle and base. The lower branches gave a larger proportion of males than the upper. I might repeat many similar experiments with the same result.

Concerning the size of the seeds, he says that the largest and smallest gave a predominating proportion of males, while those of the mean size gave more especially females.

The carefully made observations of Mr. Thomas Meehan of Germantown, Philadelphia Co., Penn., are singularly in harmony with those of Mr. Girou and others, though, I believe, made entirely independently of a knowledge of the latter.

Mr. Meehan[†] has observed that in several plants of the order Cupuliferæ, and he believes in all of them, "we find the female flowers only on the strongest young growths, and only at or near the apex of the first great wave of spring growth, as if it were the culmination of a great vegetative effort which produced them, instead of a decline as in the male."

---

[*] Girou, Suite des Expériences sur la Génération des Plantes, Annales des Sciences Naturelles, t. xxiv, pp. 138–148.

[†] On the Sexes of the Plants, Proc. Amer. Assoc. Adv. Sci., 1869, pp. 256–60. See also, *ibid.*, 1870, pp. 276–280; *ibid.*, 1868, p. 317. Proc. Acad. Nat. Sci., 1868, 9, 70. Also Gardener's Monthly (edited by Mr. Meehan), 1870, p. 333, *et al. temp.* Also Dr. S. W. Butler's Review (editorial) of Mr. Meehan's observations and deductions, Medical and Surgical Reporter, Phila., Oct. 22, 1870, p. 330, *et al. loc. Op. cit.*; also, Mr. Meehan in Old and New, Feb., 1872, p. 173 *et seq.*

In the case of Norway spruces it is "only in the fourth or fifth year, when vitality in the spur is nearly exhausted, do male flowers abundantly appear."

Mr. David Moore, in his morphology of Nepenthes,* says that "vigor and healthiness increase the female line of vital force in vegetables, while weakness is more conducive to the male development." When growth has ceased, maturity and complete development are accomplished, and the business of reproduction exclusively occupies the plant.

From all this it appears then, that while the plant is mostly occupied in vigorous growth, while it is yet succulent, *immature*, or is, in other words, *undeveloped*, does it bear the largest proportion or principally female flowers. As growth is antagonistic to development, and it is only after perfect development is reached that the reproductive function is most active, we are forced to conclude that the production of male flowers or fruit is a higher effort of the plant than the production of females.

I have ventured to enunciate it as a law† deduced from a thorough study of the subject, that the greater the fecundity, in single births, the larger the proportion of male children, and *vice versa.* I have also said that the begetting of males is a higher role in the reproductive act of the mother than the begetting of females; while the begetting of females on the part of the father is a higher reproductive role than the begetting of males.‡ In this article it has been shown that the greater the "*vigor*" (rapidity of growth and excessive vital and vegetative action) the larger the proportion of females produced. Now, it is so well known and so universally recognized and pointed out by physiologists, that this same *vigor is directly antagonistic to reproduction*, that it is scarcely necessary for me to mention it. Hence females are begotten when the system is more occupied by the process of growth, reparation or disease, than when males are begotten.

Dr. Henry Hartshorne§ has maintained Mr. Meehan's view of the relation of vigor to sex. To the facts stated I fully agree, but the deductions which they have both arrived at, viz.: that the begetting of female offspring is a higher role on the part of the mother than the begetting of males, — that is, requires a more perfect developmental effort—and as a consequence, females are more highly developed than males, are diametrically opposed to my own conclusions, as may be seen in this and in the other papers referred to.

---

* Trans. of the Royal Irish Acad., Vol. xxiv, p. 629, 1870.

† The Relative Viability of the Sexes, etc. N. Y. Medical Record, June 16, and July 15, 1873, p. 301; and Statistics of Philadelphia, Proc. Social Sci. Assoc., 1873, p. 18.

‡ See farther, in the author's thesis, already alluded to, in foot-note; also his paper on Laws of Transmission, etc., etc.

§ On the Relation between Vigor and Sex. Proc. Amer. Assoc. Adv. Sci., 1872, pp. 192–7.

The use of the word "vigor" is scarcely scientific; it has only a practical, conventional meaning, and should be studiously avoided by scientific biologists, as it is almost useless by way of comparison. Development is the proper physiological expression, and indicates the degree of evolution or maturity of the various organs of the animal or plant, and we can readily compare the different stages and degrees of development exhibited in each organ. Mr. Meehan studiously avoids the use of this last named word, and would, I am persuaded, alter his deductions if he should weigh its full meaning, and apply it in his comparisons. He cannot, however, be too highly praised for his excellent series of observations already alluded to.

With a view of showing the fallacy of the use of this word vigor, I may state that Dr. Gouverneur Emerson of Philadelphia, several years ago, discovered that "the extensive prevalence of every severe zymotic epidemic, or endemic disease; every occurrence, in fact, which exerts, either directly or indirectly, a decided, depressing effect upon a community, will be indicated in the record of births by a conspicuous reduction in the proportion of males."* He bases this opinion upon the careful study of the statistics of births in Philadelphia during the prevalence of cholera in the year 1833; also for Paris 1832. In the first named city, the percentage of excess of male births for the decade from 1830 to 1840 was 6·29, while "the diminution of male conceptions, during the cholera, was at the rate of 17 per cent." The number of conceptions during the months in which cholera prevailed was 1826 males and 1851 females, or 98·64 males to 100 females. In Paris, in 1832, the year cholera prevailed there, the excess of male conceptions was reduced from the usual average of 6 per cent. to 3½ per cent. From this we see that a "*lessened vigor*," so to speak, is accompanied by an increase in the proportion of female births; so a lessened or increased vigor may determine this increased tendency toward the production of females ; in fact, anything which operates upon the animal economy by distracting it from the business of reproduction, such as rapid and vigorous growth, developmental processes, mental anxiety, or incipient disease, will cause a lessened fecundity and an increase in the proportion of female offspring.

---

*Causes operative in determining the Proportions of the Sexes at Birth. American Journal of the Medical Sciences, July, 1848, pp. 78–85.

Mrs. Mary Treat* of Vineland, N. J., has, by repeated experiments on butterflies, found that by overfeeding a certain number, a large proportion of female eggs was produced, and that by underfeeding, or partly starving them, the proportion of male eggs was increased.

The writer has shown in his paper on "The Nationality of Parents as Affecting the Fecundity and the Proportion of Sexes in Births"† that foreign mothers (who are unquestionably more "vigorous" than native mothers) have a much larger proportion of boys among their children.

Mr. H. H. Howorth, in his paper entitled "Strictures on Darwinism,"‡ says that he "cannot but conclude that sterility is induced by vigorous health and by a plentiful supply of the necessaries of life, while fertility is induced by want and debility, and that this law acts directly against Mr. Darwin's theory, in that it is constantly recruiting the weak and the decrepit at the expense of the hearty and vigorous, and is constantly working against the favorite scheme of Mr. Darwin, that in the struggle for existence the weak are always being eliminated by the strong."

It will be seen by the above that the views of Mr. Darwin and Mr. Howorth are both extreme; the former believing that the greatest fecundity and best products belong to the most vigorous, while the latter believes that the most feeble are most prolific, and have the most vigorous offspring.

The writer is of the opinion, from a careful study of the subject, that a medium condition between these two extremes is most favorable to fecundity and the production of healthy, vigorous offspring, namely, developmental maturity of the parents, and a moderate supply of food in connection with a life most in accordance with nature.

---

*AMERICAN NATURALIST, March, 1873, Laws Controlling the Sexes in Butterflies.

†Philadelphia Medical Times, ... 1873.

‡Journal of the Anthropological Institute. London, April, 1872, pp. 21-40. p. 37. Part 1, Fertility and Sterility.

We have seen, then, that excessive "vigor" increases the proportion of females; lessened "vigor" decreases the proportion of males (apparently increases the proportion of females); and that greater "vigor" increases the proportion of males:—from all of which we conclude that there is *no constant "relationship between 'vigor' and sex."*

In my paper on the "Relative Viability of the Sexes, etc.," in which I have shown that females have a higher viability (greater longevity) than males, I ventured to ascribe this greater viability to the fact of female fetuses sapping the vitality of the mother more than males. However this be, there can be no doubt of the facts stated, for Prof. Martegoute* in his observations on the breeding of the Dishley Mauchamp merino sheep, says,—"Our monthly weighings show that the ewes that have produced female lambs are on an average of weight superior to those that produced the males; and they evidently lose more in weight than these last, during the suckling period; while the ewes that produce males, weigh less, and do not lose in nursing so much as the others."† "That is, mothers are in better condition when they *conceive* females, and are in better condition when they wean males than females." Dr. Congar‡ has observed the same thing concerning women. Dr. Spruce,§ a South American traveller, noticed that a certain palm (Geonoma) bore fruit (female flowers) one year, and male flowers the next, alternating from male to female from year to year. This same fact is seen in some animals, that bear females for several generations, then males; in fact the process of "alternation of generations" is dependent upon this principle, of which I shall have more to say in another paper.‖

I have stated that some stalks bore only male flowers, and suggested that this fact was the result of retarded fecundation of the ovule from which the stalk was produced, and I may now point out how nature allows these peculiarities to be produced.

It has been observed, says Lindley,¶ that the quantity and kind of light to which the plant is subjected determine the sex of the future products of the seeds produced under these circumstances. General Pleasonton[*] of this city has lately determined that both animals and plants thrive better under a violet colored light, which is in harmony with the experiments of Dr. Daubeny.[†] Mr. Thomas Andrew Knight[‡] observed that the relative quantity of light and heat determined the sex of the flowers produced by certain plants. Lindley says, "It will be found that no pollen is scattered in damp, cold weather, but in a sunny, warm, dry morning the atmosphere surrounding such plants, is, in the impregnating season, filled with grains of pollen discharged by the anthers. In wet springs the crops of fruit fail, because the anthers are not sufficiently dried to shrivel and discharge their contents, which remain locked up in the anther cell till the power of impregnation is lost."

---

*Journal d'Agriculture Pratique, etc.

†Goodale, Breeding, etc. of Domestic Animals. Boston, 1861, pp. 91, 92.

‡H. M. Congar, M. D., Buffalo Medical and Surgical Journal, August, 1867.

§Criticism on Dr. Spruce's article, by Dr. Wendland, in Botan. Zeitung, 1869.

‖The Cause of Rotation and nearly Equal Number of Sexes in Births.

¶Theory of Horticulture, N. Y., 1852.

Gaertner[§] has pointed out in his "Notice sur des Expériences concernant la Fécondation de quelques Végétaux," the decided influence of the state of the atmosphere on the process of fecundation. He insists on the maturity of the pollen as essential to the process. During a warm time the stamens of the rue accomplish their movements in two or three days, whilst they are, by a cold air and an advanced season, scarcely terminated in eight days. Fecundation requires also a greater quantity of pollen in the last case than in the other.[||]

This being the case, we can readily understand that a few wet days may prevent the pollen from being disseminated, while the ovules continue developing, and fecundation is retarded from this cause, and it is for this reason that the production of a larger proportion of exclusively male-producing grains is due.

Darwin[¶] says that "walnut trees, which are properly monœcious, sometimes entirely fail to produce male flowers;" and "the female silver maple will not unfrequently put forth branches of male flowers."

Some cultivator has recorded[**] a series of experiments on

---

[*] Pamphlet, Phila., 186-.

[†] Lindley, p. 172, out of Dr. Daubeny, Phil. Trans., 1836, p. 149.

[‡] Selections from Mr. Knight's Physiological Papers, pp. 347-357, out of the Phil. Trans.

[§] Naturwissenschaftliche Abhandlungen, Tubingen, 1826. t. 1. . . .

[||] Koelreuter. Vorlaenfige Nachricht von Einingen das Geschlecht der Pflanzen betreffenden Versuchen, pp. 10, 19, from Gardener's Chronicle, 1847, pp. 541-558.

[¶] Animals and Plants under Domestication.

[**] American Agriculturist, N. Y., Orange Judd, M. A., Editor.

Indian corn, with a view of obtaining the largest proportion of stalks bearing two ears. The following was the method employed; all the stalks bearing but one ear had the "tassel" (male flower) cut off before it was full blown, so that all stalks bearing two ears would be surely fecundated by the male flowers of the same or other stalks also bearing two ears, thus securing duplicity on both the male and female sides. In this way, we are told that the proportion of stalks bearing two or more ears, was increased to a considerable extent, by the planting of grains procured by this process.*

A single ovule may be fecundated by the pollen of at least two different varieties, as may be seen from Mr. Arnold's experiments given below†.

From what we have shown, it would appear that the grains near the base of the ear are less variable and more mature than those near the tip, and are consequently more desirable for seed, as they would be likely to give plants more vigorous and prolific.

I may state here that it is the habit of good farmers to select the largest and fairest ears, containing the largest, fullest, and hardest grains, for seed; and that a popular notion prevails that ears having a few remaining glumes of abnormally placed male flowers at the tip of the cob are called "female ears" and are supposed to be more prolific, at least are thought to be more desirable for "seed"; whether there be any foundation for this belief I am not informed, but am inclined to look upon it as a "vulgar error."

---

*From James Logan's experiments it would appear as if it were the rule, under ordinary circumstances, for the female flowers of plants in the same hill to be fertilized principally by the pollen from male flowers in the same hill.—Experimenta et Melcmetemata de Plantarum Generatione, auctore Jacobo Logan, Leyden, 1739. Translated into English by J. F., and published with original Latin text, opposite page. London, 1747. 8vo. pp. 32, p. 9.

†Mr. Arnold of Paris, Canada, has shown that if the female flowers of an Indian corn plant are submitted to the action of pollen from male flowers of different kinds of corn-plants, each grain of the ear produced shows the effect of both kinds of pollen. In an experiment related, a given female flower was subjected first to the action of pollen from a yellow variety of corn, and then to that taken from a white variety; the result was an ear of corn each grain of which was yellow below and white above. The conclusion presented is, not only that there is an immediate influence on the seed and the whole fruit structure by the application of strange pollen, but the more important fact that one ovule can be affected by the pollen of two distinct parents, and this, too, after some time had elapsed between the first and second impregnation. [From the author's paper on The Laws of Transmission of Resemblance from Parents to their Children. New York Medical Record, 15th of Aug., Sept., Oct., and Nov., 1873, pp. 16—out of Scribner's Monthly, Sept., 1873.]

Columella[*] and Celsus[†], in ancient times laid great stress upon the selection of seed-corn; and Virgil[‡] says—

> "I've seen the largest seeds, tho' view'd with care,
> Degenerate unless th' industrious hand
> Did yearly cull the largest."[§]

To recapitulate then,—the conclusions arrived at in this paper are:—

1. That in plants, and animals as well, that are actively occupied in vegetative, physiological, pathological or other efforts which are antagonistic or complementary to the office of reproduction, the proportion of females borne during such times is greater than where the plant or animal has reached full developmental maturity[||] and growth, is in good health, and is occupied principally in the process of reproduction. In this latter condition offspring of a higher developmental condition are produced, and the proportion of males is increased.

2. Females are in better condition (that is, they are fatter, more active in growth), more troubled by disease,[¶] or other process antagonistic to reproduction where they conceive with females than with males; and they are made poorer, become more exhausted, and less healthy, by the production of female offspring than by male products.

4. It is just possible that the ovules from which females are derived may have a higher initial vitality (vigor) though they be less highly developed than those from which males are derived, yet no egg can properly be said to be predestined *to be* male or female.

5. That female plants like female animals are less highly developed than males, and are the result of an inferior developmental reproductive effort on the part of the female parents.

---

[*] De Re Rustica.

[†] Darwin; Animals and plants under Domestication, vol. ii. p. 303.

[‡] Georgics.

[§] Darwin, *op. cit.*, vol. i, p. 319.

[||] See farther in the author's paper on The Physical Aspects of Primogeniture; or the Relative Viability of Offspring of Different Pregnancies.—New York Medical Record, January 15 and February 15, 1874.

[¶] Dr. Gouverneur Emerson was the first to point out the effect of a prevailing epidemic (cholera) in reducing the proportion of male births. See his proof in his paper in the American Journal of Medical Sciences, July, 1848, pp. 78-85.

RAMBLES OF A BOTANIST IN WYOMING TERRITORY.

BY REV. E. L. GREENE.

I.

SITUATED in the midst of a wide waste of treeless and even shrubless plains, which are at an elevation of a mile and more above the level of the sea, the city of Cheyenne would scarcely be thought a central point from which one might make many interesting little botanical excursions. The strong northwest winds, which prevail here almost incessantly, by day and by night during all the winter months, seem to sweep all the snows into the valley of the La Poudre, in northern Colorado, and leave the plains of Wyoming quite bare; so that one sees here only the short dry curly turf of buffalo and grama grasses, here and there interspersed with the spiny balls of *Echinocactus Simpsonii.* More than once during the winter of 1871–2, on the calmer, better days that are incident to even a Wyoming winter, did the writer of these notes stroll forth upon those plains, to ask of the sere grasses and withered cacti, what else could possibly grow among them in the summer.

Our first spring visit to this region was made on the twentieth of May. The grasses were beginning to show green, the little spherical *Echinocacti* were crowned each with its chaplet of rose-purple flowers, and the low matted *Phlox Douglasii* was blooming almost everywhere. A few rods from the depot of the U. P. Railway we stood upon the ridge of bluffs that overlook the turbid stream called Crow Creek, and its now beautiful little valley. The pebble beds that lie along the shore of this almost alpine river are quite gorgeous with purple and yellow. The yellow we recognize as the handsome bloom of *Thermopsis fabacea*, a common plant of this region, bearing heavy racemes of lupine-like flowers, but the purple is apparently something more interesting. It is a low growing plant, so small that although we are but a few rods from where it is, and we are looking almost straight down upon a large, dense patch of it, we cannot determine it. The color is much like that of several of our beautiful Coloradian *Astragali*, but it is not their habit to grow so thickly as to color the whole face of several acres, for taking a glance up and down the stream we behold the gravel beds everywhere purple with the same abundance of bloom. After waiting just a moment in order to enjoy the pure delight of a happy anticipation, we hasten down the steep bluff side, and find ourselves scarcely able to believe what our eyes tell us. Is it possible that *all this* is Nuttall's *Oxytropis multiceps*, one of the most rare and charming of all the plants that are peculiar to the Rocky Mountains? A plant hitherto rarely met with at all, and only on a few alpine summits in Colorado and Montana. The year before, we had taken a few depauperate specimens, in seed only, on one of the Colorado Mountains, and had prized even those poor ones very highly. It grew like a poor little half-starved stranger where we found it then; but here it is luxuriant and plentiful, and this Wyoming region is doubtless its proper home. Passing up to the bluffs of the other side, a half-mile or so away, we find two or three other very interesting little leguminous plants, *Astragalus sericoleucus*, a silky-white, spreading vetchling with purple flowers, and also the more rare *Astragalus cæspitosus*, the latter scarcely yet in full flower; and finally another, with silky-white foliage, and most splendid racemes of purple. Of this plant we found but one root, out of which we made half a dozen herbarium specimens, but it proves to be Nuttall's *O. Lagopus*. It was thought to be a species yet undescribed; Dr. C. C. Parry has this season found the same farther northward, and has collected fruit as well as flowers. All our Rocky Mountain species of this genus are beautiful, and this rare one is among the finest.

But the middle of May is rather too early in the season to find a great variety of flowers at this high altitude. We must wait about another four weeks, if we are to see these plains in all their glory.

It is now the 20th of June, and we are ascending the grade of the Denver Pacific Railway from the lower plains of Colorado, to the high lands of Wyoming. We pass the boundary line between the two territories, just as the highest point is reached. It is now about noonday, and we are but ten miles from Cheyenne. There is plenty of time for a botanist to reach the city before night, and so we beg of our conductor the privilege of making the remainder of the journey on foot; for these bluffs and table-lands are now gorgeous with flowers of many colors, and we are impatient to see what they are. The whistle sounds, and the train slackens speed, until the leap may be made with safety, and we alight. The train moves on and soon passes from our sight, and we are alone but for the distant companionship of a beautiful herd of antelope which graze upon a near hill-side, a jack-rabbit, and a colony of prairie dogs. But we were landed just on the south side of a line of snow fence, where the snows drifted deep last winter, and so moistened the ground that the flowers and grasses of June are here to be found in greatest luxuriance. Let us see what we have. Very conspicuous are some yellow heads of a composite, borne upon tall and slender scapes, and waving with the grasses in the wind. At the base of each stem is a rosette of narrow, somewhat silky leaves, and the plant is *Actinella scaposa* Nutt.

In the winter season, on the hill-tops near Cheyenne, we had noticed some close tufts of mossy-green, sharp-pointed leaves, and here we find the very plant in bloom. It has sent up numerous branching stems, two inches or more in height, bearing rather large, sandwort-like flowers. It proves to be *Arenaria Hookeri* Nutt., a rare species as well as a handsome one. The truly elegant little *Astragalus cæspitosus*, which a month ago was barely beginning to show bloom, is not yet gone by, and here we gather lovely specimens of it with the rest, and then pass on over and between various hills and bluffs, and out upon the clear green expanse of plains, toward the metropolis of Wyoming.

Now we are in the midst of a dense patch of wild peas, of a low growth, hairy leaves, and very large purple flowers; a form of *Lathyrus polymorphus* Nutt.; and a plant scarcely inferior in beauty to the best of the cultivated species of this genus.

Yonder is a slight depression in the surface of the plain, where there was more moisture in early spring. The whole spot of ground is colored dark dull red, not with flowers, but with the large showy fruits of *Rumex venosus* Pursh. Two species of Pentstemon are especially attractive among the flowers of this region; *P. cristatus* Nutt., with very large pale purple flowers, in a short rather one-sided raceme, and *P. albidus*, with smaller and almost white corollas, arranged in a long raceme. The latter species is abundant, almost whitening long lines of ridges. A very fine perennial lupine, whose specific name I cannot venture to give, with blue and black flowers borne in large dense spikes, is very noticeable on the stony hill-sides; and again in the valleys, or gentle depressions between the rolling hills, are the rich purple tufts of *Astragalus bisulcatus* Gray. This is a very handsome perennial, and would be desirable enough for cultivation, but for its disgustingly strong odor of bean-vines.

Besides these more noticeable things, our ten miles walk added to our herbal several very interesting rarities, which would have been overlooked by one who had sought only the showy and beautiful things of this interesting ground. A remarkable profusion of very handsome flowers, of a few species only, is what especially characterizes the flora of this region at this season of the year. Passing through it by rail, one sees as much of the purple and red and white and yellow of the plants mentioned, as of the common verdure of the prairie grasses.

THE PRESENT ASPECTS OF BIOLOGY AND THE METHOD OF BIOLOGICAL STUDY.*

BY PROFESSOR ALLMAN.

Conception of Biology and Function of the Scientific Method.—Under the head of Biology are included all those departments of scientific research which have as their object the investigation of the living beings—the plants and the animals—which tenant the surface of our earth, or have tenanted it in past time.

It admits of being divided under two grand heads: Morphology, which treats of Form; and Physiology, which treats of Function; and besides these there are certain departments of biological study to which both Morphology and Physiology contribute, such as Classification, Distribution, and that department of research which is concerned with the origin and causes of living and extinct forms.

By the aid of observation and experiment we obtain the elements which are to be combined and developed into a science of living beings, and it is the function of the scientific method to indicate the mode in which the combinations are to be effected, and the path which the development must pursue. Without it the results gained would be but a confused assemblage of isolated facts and disconnected phenomena; but, aided by a philosophic method, the observed facts become scientific propositions; what was apparently insignificant becomes full of meaning, and we get glimpses of the consummate laws which govern the whole.

---

* Extracts from the opening address before Section D—Biology—of the British Association for the Advancement of Science, delivered Sept. 18, 1873.

Classification an Expression of Affinities.—Hitherto we have been considering the individual organism without any direct reference to others. But the requirements of the biological method can be satisfied only by a comparison of the various organisms one with the other. Now the grounds of such comparison may be various, but what we are at present concerned with will be found in anatomical structure and in developmental changes; and in each of these directions facts of the highest order and of great significance become apparent.

By a carefully regulated comparison of one organism with another, we discover the resemblances as well as the differences between them. If these resemblances be strong, and occur in important points of structure or development, we assert that there is an affinity between the compared organisms, and we assume that the closeness of the affinity varies directly with the closeness of the resemblance.

It is on the determination of these affinities that all philosophic classification of animals and plants must be based. A philosophical classification of organized beings aims at being a succinct statement of the affinities between the objects so classified, these affinities being at the same time so set forth as to have their various degrees of closeness and remoteness indicated in the classification.

Affinities have long been recognized as the grounds of a natural biological classification, but it is only quite lately that a new significance has been given to them by the assumption that they may indicate something more than simple agreement with a common plan—that they may be derived by inheritance from a common ancestral form, and that they therefore afford evidence of a true blood relationship between the organisms presenting them.

The recognition of this relationship is the basis of what is known as the Descent Theory. No one doubts that the resemblances we notice among the members of such small groups as those we name species are derived by inheritance from a common ancestor, and the Descent Theory is simply the extension to the larger groups of this same idea of relationship.

If this be a true principle, then biological classification becomes an exposition of family relationship—a genealogical tree in which the stem and branches indicate various degrees of relationship and direct and collateral lines of descent. It is this conception which takes classification out of the domain of the purely morphological.

Affinity determined by the study of Anatomy and Development.—From what has just been said it follows that it is mainly by a comparison of organisms in their anatomical and developmental characters that their affinities are discoverable. The structure of an organism will in by far the greater number of cases be sufficient to indicate its true affinity, but it sometimes happens that certain members of a group depart in their structure so widely from the characters of the type to which they belong, that without some other evidence of their affinities no one would think of assigning them to it. This evidence is afforded by development.

A Philosophical Classification cannot form a single Rectilineal Series.—A comparison of animals with one another having thus resulted in establishing their affinities, we may arrange them into groups, some more nearly, others more remotely related to one another. The various degrees and directions of affinity will be expressed in every philosophical arrangement, and as these affinities extend in various directions, it becomes at once apparent that no arrangement of the animal or vegetable kingdom, in a straight line ascending like the steps of a ladder from lower to higher forms, can give a true idea of the relations of living beings to one another. These relations, on the contrary, can be expressed only by a ramified and complex figure which we have already compared to that of a genealogical tree.

Distribution and Evolution.—Another very important department of biological science is that of the distribution of organized beings. This may be either distribution in space, geographical distribution: or distribution in time, palæontological distribution. Both of these have of late years acquired increased significance, for we have begun to get more distinct glimpses of the laws by which they are controlled, of the origin of faunas and floras, and of the causes which regulate the sequence of life upon the earth. Time, however, will not allow me to enter upon this subject as fully as its interest and importance would deserve, and a few words on palæontological distribution are all that I can now venture on.

The distribution of organized beings in time has lately come before us in a new light by the application to it of the hypothesis of evolution. According to this hypothesis, the higher groups of organized beings now existing on the earth's surface have come down to us, with gradually increasing complexity of structure, by continuous descent from forms of extreme simplicity which constituted the earliest life of our planet.

In almost every group of the animal kingdom the members which compose it admit of being arranged in a continuous series passing down from more specialized, or higher, to more generalized or lower forms; and if we have any record of extinct members of the group, the series may be carried on through these. Now while the descent hypothesis obliges us to regard the various terms of the series as descended from one another, the most generalized forms will be found among the extinct ones, and the farther back in time we go the simpler do the forms become.

By a comparison of the forms so arranged we obtain, as it were, the law of the series, and can thus form a conception of the missing terms and continue the series backwards through time, even where no record of the lost forms can be found, until from simpler to still simpler terms we at last arrive at the conception of a term so generalized that we may regard it as the primordial stock, the ancestral form from which all the others have been derived by descent.

This root form is thus not actually observed, but is rather obtained by a process of deduction, and is therefore hypothetical. We shall strengthen, however, its claims to acceptance by the application of another principle. The study of embryology shows that the higher animals, in the course of their development, pass through transitory phases which have much in common with the permanent condition of lower members of the type to which they belong, and therefore with its extinct representatives. We are thus enabled to lay down the further principle that the individual, in the course of its own development from the egg to the fully formed state, recapitulates within that short period of time the various forms which its ancestry presented in consecutive epochs of the world's history; so that if we knew all the stages of its individual development, we should have a long line of its descent.

Through the hypothesis of evolution, palæontology and embryology are thus brought into mutual bearing on one another.

Let us take an example in which these two principles seem to be illustrated. In rocks of the Silurian age there exist in great profusion the remarkable fossils known as graptolites. These consist of a series of little cups or cells arranged along the sides of a common tube, and the whole fossil presents so close a resemblance to one of the Sertularian hydroids, which inhabit the waters of our present seas, as to justify the suspicion that the graptolites constitute an ancient and long since extinct group of the Hydroida. It is not, however, with the proper cells or hydrothecæ of the Sertularians that the cells of the graptolite most closely agree, but rather with the little receptacles which in certain Sertularinæ belonging to the family of the Plumularida we find associated with the hydrothecæ, and which are known as "Nematophores." A comparison of structure then shows that the graptolites may with considerable probability be regarded as representing a Plumularia in which the hydrothecæ had never been developed and in which their place had been taken by the nematophores.

Now it can be shown that the nematophores of the living Plumularida are filled with masses of protoplasm which have the power of throwing out pseudopodia, or long processes of their substance, and that they thus resemble the Rhizopoda, whose soft parts consist entirely of a similar protoplasm and which stand among the Protozoa, or lowest group of the animal kingdom. If we suppose the hydrotheca suppressed in a plumularian, we should thus nearly convert it into a colony of Rhizopoda, from which it would differ only in the somewhat higher morphological differentiation of its cænosarc or common living bond, by which the individuals of the colony are organically connected. And, under this view, just such a colony would a graptolite be, waiting only for the development of hydrotheca to raise it into the condition of a plumularian.

Bringing now the evolution hypothesis to bear upon the question, it would follow that the graptolite may be viewed as an ancestral form of the Sertularian hydroids, a form having the most intimate relations with the Rhizopoda; that hydranths and hydrothecæ became developed in its descendants; and that the rhizopodal graptolite became thus converted, in the lapse of ages, into the hydroidal Sertularian.

This hypothesis would be strengthened if we found it agreeing with the phenomena of individual development. Now such Plumularida as have been followed in their development from the egg to the adult state do actually present well-developed nematophores before they show a trace of hydrothecæ, thus passing in the course of their embryological development through the condition of a graptolite, and recapitulating within a few days stages which it took incalculable ages to bring about in the palæontological development of the tribe.

I have thus dwelt at some length on the doctrine of evolution because it has given a new direction to biological study and must powerfully influence all future researches. Evolution is the highest expression of the fundamental principles established by Mr. Darwin, and depends on the two admitted faculties of living beings—*heredity*, or the transmission of characters from the parent to the offspring; and *adaptivity*, or the capacity of having these characters more or less modified in the offspring by external agencies, or it may be by spontaneous tendency to variation.

The hypothesis of evolution may not, it is true, be yet established on so sure a basis as to command instantaneous acceptance; and for a generalization of such vast significance no one can be blamed for demanding for it a broad and indisputable foundation of facts. Whether, however, we do or do not accept it as firmly established, it is at all events certain that it embraces a greater number of phenomena and suggests a more satisfactory explanation of them than any other hypothesis which has yet been proposed.

With all our admiration, however, for the doctrine of evolution as one of the most fertile and comprehensive of philosophic hypotheses, we cannot shut our eyes to the difficulties which lie in the way of accepting it to the full extent which has been sometimes claimed for it. It must be borne in mind that though among some of the higher vertebrata we can trace back for some distance in geological time a continuous series of forms which may safely be regarded as derived from one another by gradual modification—as has been done, for example, so successfully by Prof. Huxley in the case of the horse—yet the instances are very few in which such a sequence has been actually established; while the first appearance in the earth's crust of the various classes presents itself in forms which by no means belong to the lowest or most generalized of their living representatives. On this last fact, however, I do not lay much stress, for it will admit of explanation by referring it to the deficiency of the geological record, and then demanding a lapse of time—of enormous length, it is true—during which the necessary modifications would be in progress before the earliest phase of which we have any knowledge could have been reached.

Again, we must not lose sight of the hypothetical nature of those primordial forms in which we regard the branches of our genealogical tree as taking their origin; and while the doctrine of the recapitulation of ancestral forms has much probability, and harmonizes with the other aspects of the evolution doctrine into a beautifully symmetrical system, it is one for which a sufficient number of actually observed facts has not yet been adduced to remove it altogether from the region of hypothesis.

Even the case of the graptolites already adduced is an illustration rather than a proof, for the difficulty of determining the true nature of such obscure fossils is so great that we may be altogether mistaken in our views of their structure and affinities.

To me, however, one of the chief difficulties in the way of the doctrine of evolution, when carried out to the extreme length for which some of its advocates contend, appears to be the unbroken continuity of inherited life which it necessarily requires through a period of time whose vastness is such that the mind of man is utterly incapable of comprehending it. Vast periods, it is true, are necessary in order to render the phenomena of evolution possible; but the vastness, which the antiquity of life, as shown by its remains in the oldest fossiliferous strata, requires us to give to these periods, may be even greater than is compatible with continuity.

We have no reason to suppose that the reproductive faculty in organized beings is endowed with unlimited power of extension, and yet to go no farther back than the Silurian period—though the seas which bore the Eozoon were probably as far anterior to those of the Silurian as these are anterior to our own—the hypothesis of evolution requires that in that same Silurian period the ancestors of the present living forms must have existed, and that their life had continued by inheritance through all the ramifications of a single genealogical tree down to our own time; the branches of the tree, it is true, here and there falling away, with the extinction of whole genera and families and tribes, but still some always remaining to carry on the life of the base through a period of time to all intents and purposes infinite. It is true that in a few cases a continuous series of forms regularly passing from lower to higher degrees of specialization, and very probably connected to another by direct descent, may be followed through long geological periods, as, for example, the graduated series already alluded to, which may be traced between certain mammals of the Eocene and others living in our own time, as well as the very low forms which have come down to us apparently unmodified from the epoch of the Chalk. But incalculably great as are these periods, they are but as the swing of the pendulum in the millennium, when compared to the time which has elapsed since the first animalization of our globe.

Is the faculty of reproduction so wonderfully tenacious as all this, that through periods of inconceivable duration, and exposed to influences the most intense and the most varied, it has still come down to us in an unbroken stream? Have the strongest which had survived in the struggle for existence necessarily handed down to the strongest which should follow them the power of continuing as a perpetual heirloom the life which they had themselves inherited? Or have there been many total extinctions and many renewals of life—a succession of genealogical trees, the earlier ones becoming old and decayed, and dying out, and their place taken by new ones which have no kinship with the others? Or, finally, is the doctrine of evolution only a working hypothesis which, like an algebraic fiction, may yet be of inestimable value as an instrument of research? For as the higher calculus becomes to the physical inquirer a power by which he unfolds the laws of the inorganic world, so may the hypothesis of evolution, though only a hypothesis, furnish the biologist with a key to the order and hidden forces of the world of life. And what Leibnitz and Newton and Hamilton have been to the physicist, is it not that which Darwin has been to the biologist?

But even accepting as a great truth the doctrine of evolution, let us not attribute to it more than it can justly claim. No valid evidence has yet been adduced to lead us to believe that inorganic matter has become transformed into living, otherwise than through the agency of a preëxisting organism, and there remains a residual phenomenon still entirely unaccounted for. No physical hypothesis founded on any indisputable fact has yet explained the origin of the primordial protoplasm, and, above all, of its marvellous properties which render evolution possible.

Accepting, then, the doctrine of evolution in all freedom and in all its legitimate consequences, there remains, I say, a great residuum unexplained by physical theories. Natural Selection, the Struggle for Existence, the Survival of the Fittest, will explain much, but they will not explain all. They may offer a beautiful and convincing theory of the present order and fitness of the organic universe, as the laws of attraction do of the inorganic, but the properties with which the primordial protoplasm is endowed—its heredity and its adaptivity—remain unexplained by them, for these properties are their cause and not their effect.

For the cause of this cause we have sought in vain among the physical forces which surround us, until we are at last compelled to rest upon an independent volition, a far-seeing intelligent design. Science may yet discover even among the laws of physics the cause it looks for; it may be that even now we have glimpses of it; that those forces among which recent physical research has demonstrated so grand a unity—light, heat, electricity, magnetism—when manifesting themselves through the organizing protoplasm, become converted into the phenomena of life, and that the poet has unconsciously enunciated a great scientific truth when he tells us of

> "Gay lizards glittering on the walls
> Of ruined shrines, busy and bright
> As though they were *alive with light*."

But all this is only carrying us one step back in the grand generalization. All science is but the intercalation of causes, each more comprehensive than that which it endeavors to explain, between the great primal cause and the ultimate effect.

I have thus endeavored to sketch for you in a few broad outlines the leading aspects of biological science, and to indicate the directions which biological studies must take. Our science is one of grand and solemn import, for it embraces man himself and is the exponent of the laws which he must obey. Its subject is vast, for it is life, and life stretches back into the illimitable past, and forward into the illimitable future. Life, too, is everywhere. Over all this wide earth of ours, from the equator to the poles, there is scarcely a spot which has not its animal or its vegetable denizens—dwellers on the mountain and on the plain, in the lake and on the prairie, in the arid desert and the swampy fen; from the tropical forest with its strange forms and gorgeous colors and myriad voices, to the ice-fields of polar latitudes and those silent seas which lie beneath them, where living things unknown to warmer climes congregate in unimaginable multitudes. There is life all over the solid earth; there is life throughout the vast ocean, from its surface down to its great depths, deeper still than the lead of sounding line has reached.

And it is with these living hosts, unbounded in their variety, infinite in their numbers, that the student of biology must make himself acquainted. It is no light task which lies before him — no mere pastime on which he may enter with trivial purpose, as though it were but the amusement of an hour; it is a great and solemn mission to which he must devote himself with earnest mind and with loving heart, remembering the noble words of Bacon: —

"Knowledge is not a couch whereon to rest a searching and restless spirit; nor a terrace for a wandering and variable mind to walk up and down with a fair prospect; nor a tower of state for a proud mind to raise itself upon; nor a fort or commanding-ground for strife and contention; nor a shop for profit and sale; but a rich storehouse for the glory of the Creator, and the relief of man's estate."

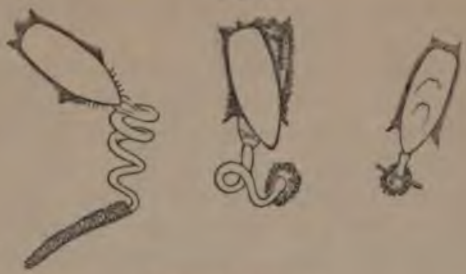
REVIEWS AND BOOK NOTICES.

THE SYSTEMATIC POSITION OF THE BRACHIOPODS.* — To those accustomed to find the Brachiopods invariably mentioned in palæontological as well as zoological works as shell-fish, with no hint of an affinity to any other class of animals, the author's remark at the beginning of his essay that "the Brachiopoda are true worms, with possibly some affinities to the Crustacea, and that they have no relations to the Mollusca, save what many other worms may possess in common with them," will seem in its nature somewhat iconoclastic. But we should remember that Cuvier regarded the barnacles as Mollusca, and it was not until 1830 that Thompson and Burmeister demonstrated from their mode of growth that these shell-bearing animals were undoubted Crustacea; the Serpulæ and Spirorbes were regarded as shell-fish by many collectors, and even the bivalve phyllopods (Estheria) of our fresh-water pools are daily mistaken by collectors for species of Cyclas. On the other hand certain worms, such as the flat worms or Planarians, have been regarded as allied to the snails and slugs by good naturalists.

---

* The Systematic Position of the Brachiopoda. By Edward S. Morse. (From the Proceedings of the Boston Society of Natural History, xv. Published August, 1873. 8vo. pp. 60.)

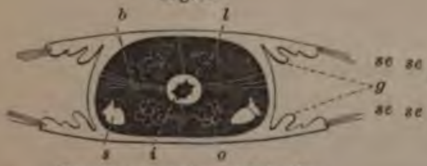
Fig. 1.



Lingula pyramidata.

We will now attempt, so far as is possible, to condense the paper of Professor Morse by giving his chief arguments for considering the "Lamp-shells" as worms. He first defines the two classes. The worms have an elongate form, while that of the

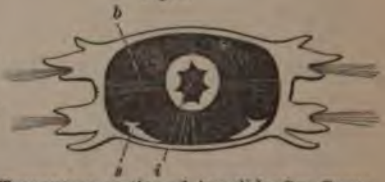
Fig. 2.



Transverse section of Lingula.

b, bands suspending intestine in perivisceral cavity; *i*, intestine; *s*, segmental organ; *o*, ovaries; *l*, liver; *g*, gills; *se*, *se*, setæ.

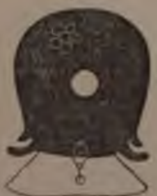
Fig. 3.



Transverse section of Annelid, after Carus.

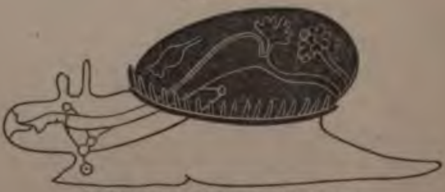
b, bands suspending intestine in perivisceral cavity; *i*, intestine; *s*, segmental organ; *se*, *se*, setæ.

Fig. 4.



Transverse section of molluscan archetype, after Carus.

Fig. 5.

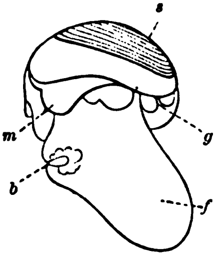


Molluscan archetype, after Carus.

mollusk is concentrated or sac-like; hence the term Saccata applied to them by Professor Hyatt.

In the mollusk the viscera are usually contained in a large chamber protruding above the foot, while in the worm "the symmetry of the body is never disturbed by the viscera." In the mollusk, moreover, the mantle is sac-like, "inclosing a conspicuous cavity," and protecting the gills, while the alimentary canal is straight in the worm, rarely convoluted, and suspended freely in the perivisceral cavity, by bands (Fig. 1, b); in the mollusk this organ is always convoluted, and intimately blended, or united, with other organs. The nervous system of the worms consists of a nerve collar from which start two parallel chains of ganglia, while in the mollusks there is a nerve collar, but no double chain, and instead, nerves are thrown out to the sensory, motor and parieto-splanchnic regions. The eggs of worms are usually (except in the leeches) set free in the general cavity of the body, which is not the case with the mollusks. Lastly, the embryo mollusk (Fig. 6) early develops a shell composed of one or two pieces, while the embryonic worm is usually distinctly ringed, as seen on the opposite page.

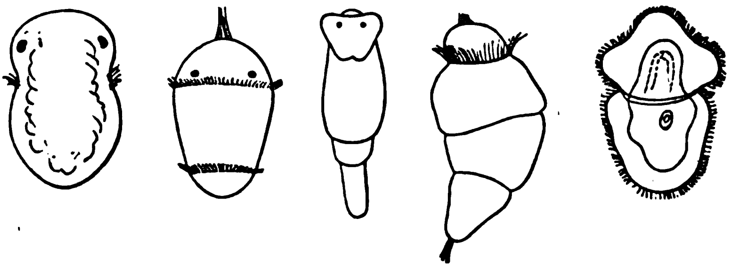
Fig. 6.



Embryo of Lamellibranchiate.
s, shell; *m*, mouth; *f*, foot; *b*, byssal gland; *g*, gills.

Here, in passing, we would remark that while the mollusks are admirably characterized, the author has, we think, failed to give sufficient importance to the most fundamental and important character in the typical worm. Certainly the ringed, segmented structure of the worm is that which, more than any other character, separates it from other animals, and when the rings are absent, as in the Planarians, Nematoids and other low worms, this is an adaptive character resulting from their peculiar habits. Moreover it should be remembered that our author regards the Brachiopods as a division of Chætopod worms, in which the segments are invariably present, and form the most important feature of those animals. Again, we fail to find any reference to the relation of the most important anatomical systems (the nervous, circulatory system and digestive canal) to the walls of the body. The correlation in structure of the nervous system of the higher worms to the segmented structure is also most intimate and remarkable.

Fig. 7. Fig. 8. Fig. 9. Fig. 10. Fig. 11.



Embryos of Worms.

Fig. 7, Serpula; Fig. 8, Spio; Fig. 9, Melicerta (Rotifer); Fig. 10, Pileolaria; Fig. 11, Phoronis; (Fig. 7, original; Figs. 8 and 10, from Claparède; Fig. 9, from Huxley; Fig. 11, from Dyster.)

Fig. 12. Fig. 13. Fig. 14.

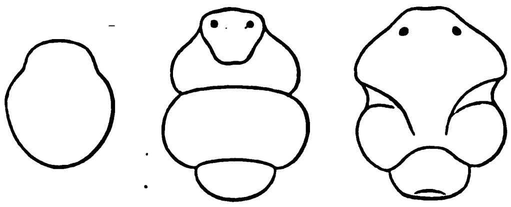
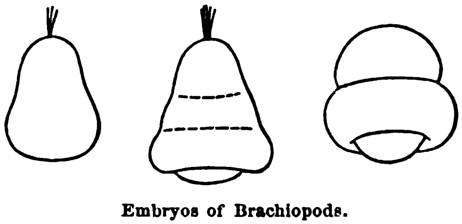


Fig. 15. Fig. 16. Fig. 17.



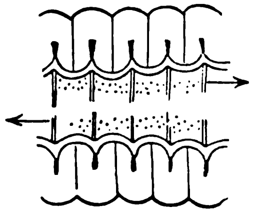
Embryos of Brachiopods.

Figs. 12, 13, 14, Thecidium (from Lacaze Duthiers).

Figs. 15, 16, 17, Terebratulina (original).

To this deficiency in the definitions, otherwise so full, we shall recur in noticing the author's conclusions as to the more immediate relationship of the Brachiopoda. It may also be noticed that in none of the diagrams of the transverse sections of the worms are the positions of the dorsal vessel or nervous cord in relation to the body walls indicated; and in this respect the same view of the mollusk is unsatisfactory. This is said not so much by way of criticism, as to call attention to important differences between the Brachiopods and Chætopodous worms, which demand serious consideration in accepting the conclusions as to the precise systematic position of the Brachiopods claimed by the author.

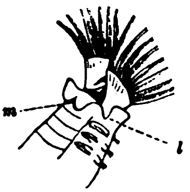
Fig. 18.



Portion of Peduncle of *Lingula pyramidata*, showing annulations, and circulation of fluid within.

Farther on, in speaking of the general proportions of the body, it seems that the author does not lay much stress on the ringed structure of the higher worms, of which it should be borne in mind he considers the Brachiopods to form a division. Thus it is stated, almost casually, that "a prominent character of the higher worms is the annulations or rings marking the body." As, however, the annulations are wanting in certain low worms (*i.e.* the Gephyrea or Sipunculoid worms, Sagitta, Nematoidea, Acanthocephala*) the absence of this character in the Brachiopods is unimportant; still, however, the peduncle of Lingula is "partially annulated" (Fig. 18).

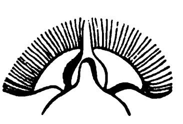
Fig. 19,



Showing cephalic collar of Sabella. *m*, median dorsal notch; *l*, lateral notch.

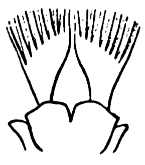
The comparison between the mollusks and worms is then extended to the integumentary organs. Here, in an exceedingly suggestive way, the author shows that in the worms the integument is rarely ever extended beyond the limits of the body; but when

Fig. 20.



Head of Discina.

Fig. 21.



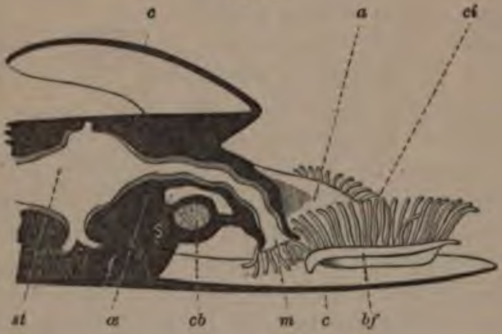
Head of Sabella.

---

*It should be borne in mind that these worms are mostly parasitic, or, as in Sagitta and Sipunculus, very aberrant forms, and the absence of rings is probably a secondary or adaptive character.

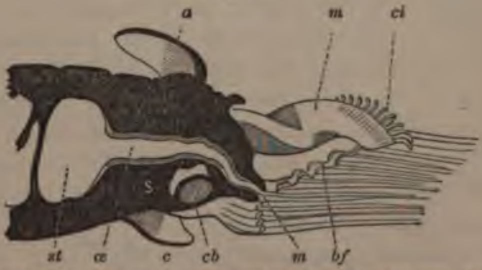
it is it forms a broad cephalic collar, "covering the base of the arms in those worms possessing it (as in Sabella, Fig. 19), while in the Brachiopoda the collar covers and protects the arms," and this collar is not to be compared with the mantle of mollusks. On page 27 the cephalic region of the true worms is discussed, and the intimate relationship between the head of certain worms, such as Sabella and Amphitrite, and that of the Brachiopods, shown. This can be seen by a glance at the accompanying figures. We cannot farther abstract the condensed statement of the author. By making a longitudinal section of the worm Amphitrite, and the brachiopod Lingula, the most interesting relationship may be detected (Figs. 22 and 23).

Fig. 22.



Longitudinal section of anterior portion of Lingula.

Fig. 23.

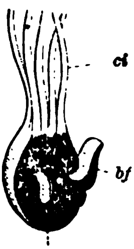


Longitudinal section of anterior portion of *Amphitrite ventrilabrum*.

m, mouth; *œ*, œsophagus; *st*, stomach; *a*, arm; *ci*, cirri; *bf*, brachial fold; *cb*, cartilaginous base of arm; *s*, sinus leading to arm; *cc*, cephalic collar or pallial membrane.

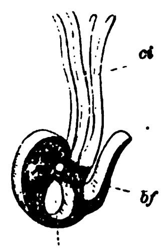
Considering the arms alone we are told that a transverse section of a right arm of Amphitrite (Fig. 24) resembles that of Lingula, (Fig. 25) much more than "corresponding sections of two Brachiopods resemble each other."

Fig. 24.



Transverse section of arm of *Amphitrite ventrilabrum.*

Fig. 25.

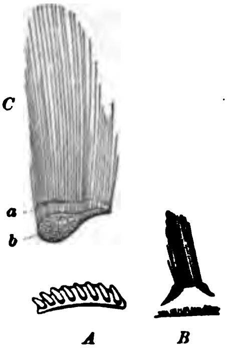


Transverse section of arm of *Lingula pyramidata.*

ci, cirri; *bf*, brachial fold; *s*, sinus.

Bristles like those of worms, moved by muscles, and quite unlike the stiff spines of the Chitons occur in the Brachiopods. The muscles of the integument bear the closest resemblance to those of worms. The perivisceral cavity is shown to be, like that of worms, lined with a delicate membrane and strongly ciliated. Prof. Morse has succeeded in finding a vessel on the dorsal surface of the intestine of Lingula, but not the vesicle described by Hancock. But still he, as well as others, has never succeeded in studying the vascular system satisfactorily. He, however, alludes to a pseudo-hæmal system of organs, being a set of membranes which invest the oviducts, and has traced the circulation in living Rhynchonellæ. This subject, and the circula-

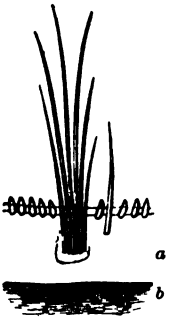
Fig. 26.



Chiton spiculosus, Gray.

A. side view of Chiton, magnified; *B*, side view of one tuft of bristles in the girdle; *C*, a tuft of bristles largely magnified; *a*, line of girdle; *b*, base of tuft.

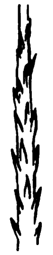
Fig. 27.



Amicula Emersonii.

a, cartilaginous layer; b, muscular layer.

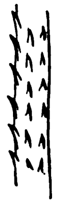
Fig. 28.



Nerine cirratulus.

Deciduous seta of larval worm, *Nerine cirratulus*, from Claparède.

Fig. 29.



Discina.

Deciduous seta of larval Discina, from Fritz Müller.

tion of Lingula, which has red blood, is reserved for discussion in a subsequent memoir. The digestive canal of the Brachiopods, as well as the circulatory system, does not compare well with those of the normal worms.

> "The anomalous features presented by some worms, in the absence of an anus, or the possession of a cœcal stomach, and the anterior termination of the anus, are fully repeated in the Brachiopoda. In one entire division of the Brachiopoda, represented by Terebratula, the stomach terminates in a cœcal sac. In Terebratulina the alimentary tract is closed posteriorly. Nor has the slightest trace of an anus been detected in Thecidium, Waldheimia, Rhynchonella, and several other genera that have been examined. In the very early stages of Terebratulina, I have seen the rejectamenta escape from the mouth, and in no case has the appearance of an anal perforation been discovered. In Terebratulina, the alimentary tract pursues a direct antero-posterior course without convolutions, while in Lingula and Discina the anus terminates anteriorly on the right side. In Lingula, the intestine makes a few turns, while in Discina it makes a single turn to the right."

The nervous system is much as in the worms, there being two lateral ventral cords, widely separated (in Lingula these lateral threads seem to be double and connected by commissures) and connected at the œsophagus by ganglionic enlargements, which send off threads to the pallial membranes, and to the various muscles. The breathing organs of Brachiopods are contained in the pallial membrane, which is divided into two oblique transverse sinuses, apparently resembling the interior of the branchia of a worm. The genital organs are almost identical with those of worms, as may be seen by a study of Figs. 30–40.

We now quote the author's conclusions in his own words:—

> "In considering the assemblage of remarkable characters in the Brachiopods, we must recognize in them a truly ancient type, and consequently a synthetic, or comprehensive type. Thus while we do not find them in all their characters resembling any one group of worms, I have endeavored to show that all their features, to a greater or less degree, are shared by one or the other of the various groups of the Vermes, with one or two features shared by the Arthropods.
>
> It is important to remark in this connection that most of the ancient groups differ from present groups with which they are associated. Thus the Trilobites are widely unlike modern Crustaceans, Milne-Edwards and Van Beneden suggesting their affini-

Fig. 30.

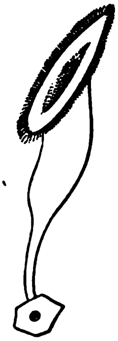


Fig. 31.

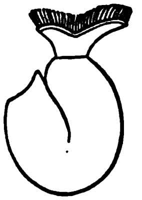


Fig. 32.

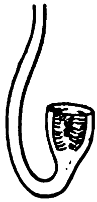


Fig. 33.

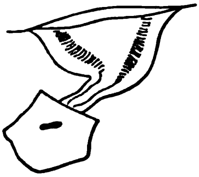
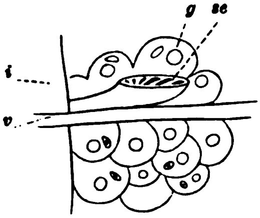


Fig. 34.



Segmental organs of worms.

Fig. 30, Lumbricus; Fig. 31, Pectinaria; Fig. 32, Eunice; Fig. 33, Stylodrilus; Fig. 34, Nereis; *se*, segmental organ, *g*, genitalia, *v*, vascular channel, *i*, intestine; Fig. 30 is from Lankester, the rest from Claparède.

Fig. 35.

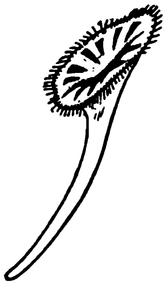


Fig. 36.

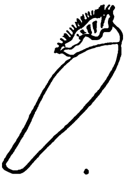


Fig. 37.

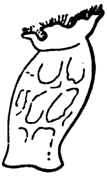
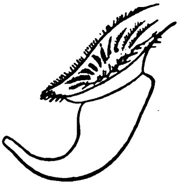


Fig. 38.



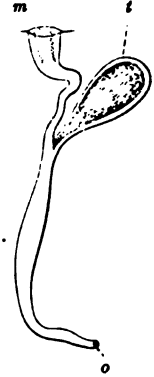
Segmental organs of the Brachiopods.

Fig. 35, Discina; Fig. 36, Lingula; Fig. 37, Rhynchonella; Fig. 38, Terebratulina. These figures are from Morse's own studies.

ties with the Arachnids. Tetrabranchiate Cephalopods are widely separated from the Dibranchiate Cephalopods. Crinoids are widely unlike modern Echinoderms. In other words, among the Mollusks, Echinoderms and Crustaceans are ancient types widely different from the modern types with which they are correlated.

So in worms we should expect to see ancient types, while presenting a high organization, yet differing from present groups to which they are unquestionably related. And from the high complication of structure of the Brachiopods, Tetrabranchiates, and other ancient types, it would seem that in their culmination in ancient times they had the same relation to animals living then as the higher groups of present times bear to their associates. As to the more ancient forms of Brachiopods, it is probable with them, as with other groups, that their lower members were soft-bodied, and the argument that has been urged, as militating against Darwin, that animals of high complication of structure occur in the older groups, becomes valueless, when we consider that the lower forms of their respective groups are more often soft-bodied, and that complicated forms of earlier times were also culminating forms of preëxisting groups. * * * * *

Fig. 39.



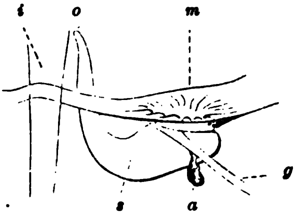
Segmental organ of *Alciope Cantrainii.*

m, inner mouth, of segmental organ; *o*, external orifice of ditto; *t*, testis.

To sum up the whole then:—ancient Chætopod worms culminated in two parallel lines, on the one hand in the Brachiopods, and on the other, in the fixed and highly cephalized Chætopods. The divergence of the Brachiopods, having been attained in more ancient times, a few degraded features are yet retained, whose relationships we find in the lower Vermes; while from their later divergence the fixed and cephalized Annelides are more closely allied to present free Chætopods.

And so we must regard the Brachiopods as *ancient cephalized Chætopods*, while Serpula, Amphitrite, Sabella, Protula and others, may be regarded as *modern* (later) *cephalized Chætopods.*"

Fig. 40.



Segmental organ of Terebratulina.

s, segmental organ; *m*. inner mouth of ditto; *o*. external orifice of ditto; *g*. genital band; *a*, accessory vesicle; *i*, intestine.

Aside from the great interest of the memoir, the skilful and concise manner in which the facts, — many discovered by the author himself after the most patient study, which would in themselves commend the work to every one — are presented, we think the author has demonstrated, in the clearest manner, that the Brachiopods are worms. And we congratulate ourselves that this important discovery of the obscure relationship of these animals has been made by an American naturalist, with the advantages presented in this country.

Still, from the facts so clearly set forth, we doubt whether the Brachiopods should, even with all the important Chætopod characters they present, be included in the division of Chætopod worms, but rather look forward to their being united with the Polyzoa in a division equivalent, perhaps, to the rest of the worms, at least the Chætophora and Discophora combined, and forming a somewhat parallel group. The Brachiopods, certainly, from Prof. Morse's own showing, have not either such a nervous system, or respiratory or circulating organs, or an annulated body, as would warrant their union with the Chætopods. He has fully proved that they are a synthetic type, combining the features of different groups of worms and other articulate animals, and in doing so he virtually forbids our sharing his view as to their special Chætopod nature. We would prefer, in speculating on their ancestry, to derive the Brachiopods and Polyzoa from a common vermian ancestry, not much higher than the Rotifers, from which sprung two stems; one resulting in the Polyzoa, and the other in the more highly and specially-developed Brachiopods, while the Chætopods were probably derived independently from an ancestry higher perhaps, but vaguely resembling the Rotifers. As to the molluscan affinities of these animals, let those prove them who can, after going over step by step the track revealed by the patient and toilsome researches of our author.

NORTH AMERICAN GRASSHOPPERS.*—Dr. Hayden proposes to collect, in a single quarto volume, papers upon the zoology and botany of the Rocky Mountain region explored by him in his government surveys. The fishes and reptiles will be elaborated by Professor Cope, the botany by Professor Porter, Hemiptera by Mr. Uhler, Coleoptera by Dr. Horn, birds by Dr. Coues and mammals by Professor Gill. The first part, on a portion of the Orthoptera, is now published, and if the whole work is executed upon the same scale, one volume cannot contain it all: let us hope that it will not. In the part before us, Dr. Thomas does not confine himself to the study of Rocky Mountain forms, but includes the Acridians of the whole of North America. It is preceded by an introductory statement of the external and internal structure of insects of this group, with especial reference to parts used in description; by an exposition of the author's idea of classification and by notes on the geographical distribution of the genera and species. In the body of the work one hundred and twenty species and twenty-five genera of U. S. Acridians are described; forty species and four genera as new. In the second part, the extra-limital species are described, but no new species are mentioned; and nearly all the descriptions, as well as many of those in the first part, are borrowed; it would have been well if the author had appended the describers' names. The work is accompanied by a well executed plate (none too large) in which, strange to say, nearly one-third of the figures are of European species,—copied from Fischer's work; surely, from the abundant material in the author's possession, suitable specimens could have been found for illustration.

---

*Report of the U. S. Geological Survey of the Territories. F. V. Hayden, Geologist in charge. Vol. v. Zoology and Botany. Part i, Synopsis of the Acrididæ of North America, by Cyrus Thomas, Ph.D. 4to. pp. x, 262. Washington, 1873.

BRITISH MARINE SEAWEEDS.*—This is a convenient little book, of which four parts have already appeared, and five or six are to follow. Mr. Grattan, whose home is at Torquay in Devonshire, a place famous in the history of British natural history, is a thorough enthusiast in seaweeds, and finding that the standard treatises on them were too scientific for the use of ordinary amateurs, and withal quite expensive, he has prepared this work, which is so simple that the most inexperienced student can readily understand it, while the price, sixpence sterling for each part, is moderate enough. Since a very large proportion of our New England algæ consists of species occurring on the shores of Great Britain, and since Harvey's Nereis, the only work on the algæ of the United States, is costly and not suited to the needs of amateurs, this book will be very useful to those who not only collect, but desire to know something about seaweeds and sea-mosses.—DANIEL C. EATON.

LUBBOCK'S MONOGRAPH OF THE PODURÆ.—Sir. John Lubbock has recently published a "Monograph of the Collembola and Thysanura." It forms a volume, in octavo, of the Ray Society. The work is beautifully, indeed lavishly, illustrated with seventy-eight plates, of which thirty-one are colored, nearly every plate representing a distinct species highly magnified. The work will commend itself to microscopists, as it is accompanied by an essay, by Mr. Joseph Beck, on the scales of certain Poduræ, with figures of the scales highly magnified.

---

* British Marine Algæ: being a popular account of the Seaweeds of Great Britain, their collection and preservation. Illustrated. By W. H. Grattan. London: "The Bazaar" office, 32 Wellington street, Strand, W. C.

BOTANY.

Irritability of the Leaves of the Sundew.—In our last number attention was called to the old observations of Roth respecting the irritability of Drosera leaves. It will be interesting to our readers to glance at a short abstract of Roth's treatise.*

The author begins by referring to the difficulty of drawing any line of demarcation between animals and plants. Some plants were believed, by the ancient philosophers, to possess a soul, since they appear to share with animals a kind of sensitiveness and motion. The word *sensitiveness* is, on some accounts, objectionable and it may be better, therefore, to employ the term *irritability*. A few plants possess this irritability in a high degree, but may we not ascribe to others, irritability less in degree? The author next refers to the kindred plants *Dionæa muscipula* and *Drosera*, intimating that the latter has, in a slight degree, the kind of irritability which characterizes the flytrap. He then describes the action of Dionæa in catching insects, and proceeds to give an account of the two more common species of sundew, *Drosera rotundifolia* and *longifolia*.

In July, 1779, while on a botanical excursion, Roth observed that some leaves of both species of Drosera had closed. Upon separating the infolded surfaces, he discovered dead insects, whereupon he asked himself whether sundew did not act just as Dionæa does. He transferred healthy plants to his house and proceeded to make the following experiments: —

1st. He placed, by a pair of pincers, an ant on the open leaf of *Drosera rotundifolia*. As soon as the ant tried to recover its freedom, the hairs of the leaf turned towards his body, and the edges of the leaf rolled over towards him. In a few minutes the ant was concealed in the infolded leaf. The insect was killed by this imprisonment. This experiment was repeated upon other leaves and with nearly the same results.

---

*Von der Reizbarkeit der Blätter des sogenannten Sonnenthaues (Drosera rotundifolia, longifolia.) Beyträge zur Botanik, Erster theil. s. 60. Von Albrecht Wilhelm Roth. Bremen, 1782. On the Irritability of the Leaves of the so-called Sundew (Drosera rotundifolia). p. 60. By Albrecht Wilhelm Roth. 1782.

2nd. He placed a little fly, being careful not to injure it, on a leaf of *Drosera rotundifolia*. The insect made some movements to gain his liberty, but he soon died, as did the ants in the previous experiments. The hairs bent inwards as before. The experiment began at eleven A. M. At five o'clock P. M. the leaf had completely closed and held the fly within.

The third observation was made upon a specimen of *Drosera longifolia*. An ant was employed, and with the same results as before. It is interesting to note the following on p. 64:—"Dieses Zusammenklappen erfolgt aber auch ebenso wenn man ein Strohhälmchen oder eine Stecknadel zwischen dieselben bringt."

The author makes some remarks relative to the similarity of action in the two genera, Dionæa and Drosera. The most interesting note, however, is that in respect to the *purpose* of the irritability.

"Mr. Ellis suggests in his letter to Linnæus that nature, by the formation of the leaf of Dionæa, may perhaps have designed it to aid in its nourishment. Schreber, however, believes it is unlikely that plants should draw nourishment from insects pressed between their leaves. It is certain that we cannot determine positively what object the wise Creator may have had in giving to these plants this wonderful structure and irritability, but I believe that we may assume safely that this structure and faculty of these plants may tend, through this nourishment, to the preservation and propagation of their kind. We cannot yet determine whether these plants may not need for their support animal juices. Besides, knowing as we do that these plants have, chiefly on their leaves, an apparatus by which they may draw from the air foreign bodies for their nourishment, we have no reason to doubt this possibility."

The author claims that no one had preceded him in this investigation.

In 1802, Roth published the following note (Neue Beyträge zur Botanik, von Al. W. Roth. Erster Theil. Frankf. am Mayn. 1802. p. 185). "In Droseris Germanicis simile phænomenon observatur et non minus miraculosum, quam in Dionæa muscipula, Foliorum scilicet pili apice oriferi ab Insecto irritati inflectuntur, inflexi Insectum incarcerant, et folium demum complicatum incarceratum tenet."

Passing over the statements in De Candolle's "Introduction à l'étude de la Botanique" (Tome 1, p. 415) 1835; in Treviranus' Physiologie der Gewächse (1838, vol. ii, s. 759), in Meyen's Neues System der Planzen Physiol. vol. iii, s. 550, we find in Botanische Zeitung, June 29, 1860, an article by Nitschke, detailing an extensive series of experiments upon Drosera. These results, together with the very curious observations published in Comptes Rendus last year, we will present at an early day, feeling quite confident that many of our readers will carefully repeat some of these experiments during the coming season.—G. L. G.

ZOOLOGY.

A NEW ÆGERIAN MAPLE BORER.—Last June my attention was drawn to numerous castings, similar to those of the peach tree borer (*Trochilium exitiosum* Say) projecting from the trunk of the soft maple trees surrounding our university yard. Having approached one of these trees I found several moths already hatched out, the most of the maple trees having been destroyed by this pernicious insect, which, boring in the bark and sap-wood, not only hinders the sap from circulating, but also enfeebles the trunk so that it is no longer able to support the weight of its foliage.

During this summer a dozen of these trees were broken down, and the few still standing are in such a condition that I believe they will not resist the winds of a second season. This condition of things induced me to pay close attention to this insect—studying its habits and collecting specimens. I failed to find it described in any of the entomological works of the university library and I have been informed that Dr. Le Baron, State Entomologist, was not aware of any Ægerians feeding on the maple tree.

My confidence in this second statement having been reënforced by a similar answer of several men of experience that I consulted on the matter, I came to the conclusion that this insect is a new destroyer and enemy of our best shade tree. I therefore give you a description* of this insect, adding what I could observe on its habits in the last two months and a half. It feeds on the inner bark and on the sap-wood. When fully fed it spins its cocoon near the surface of the outer bark. Early in the morning it makes its way out of the cocoon and the very thin layer of bark that covers it, leaving the cast skin half emerged from the orifice on the trunk, and appearing in a winged state. The females in laying their eggs, select the roughest places of *any part* of the trunk — and not of the base only, as the *T. exitiosum* — where they deposit them one in a place. The larvæ are found under the bark at any time and in all sizes. — P. GERMADIUS, *Champaign, Ill.*

---

*TROCHILIUM ACERICOLUM, n. sp. The female, the perfect insect of this Ægeria, measures across the wings from 13-16 to 15-16 of an inch; its wings are transparent. FORE WINGS; the tips yellowish, opaque, with black veins; front margin and fringe black; a steel-blue transverse band beyond their middle. HIND WINGS with a steel-

A SPINOUS FIN IN A MINNOW. — A genus of fishes (*Protistius* Cope) has been recently discovered in the Ecuadorian Andes, which in its general structure appears to belong to the bull-minnows (*Cyprinodontidæ*). Its head and mouth, however, resemble those of a mullet (*Mugil*) and it has a rudimental spinous dorsal fin consisting of a single small spine, which is bound to the back by membrane so as to be capable of but little erection.

GEOLOGY.

RETURN OF PROFESSOR MARSH'S EXPEDITION.—Prof. O. C. Marsh and party returned to New Haven, November 7th, after an absence of five months in the Rocky Mountain region and on the Pacific Coast. The present expedition had the same object in view as those of previous years, viz: a study of the vertebrate fossils of the west, especially those of the Cretaceous and Tertiary formations. The first explorations this year were made in the Pliocene deposits near the Niobrara River. The party fitted out in June at Fort

---

blue spot in the middle of the fore margin; fringe black. TAIL (caudal tuft) deep orange. ABDOMEN, above steel-blue; beneath, except the second ring from the thorax, steel-blue and golden-yellow with a longitudinal orange line in the middle. THORAX shining brown-yellow. LEGS hairy, yellow, spotted with orange and steel-blue; femur of the front pair, orange. Prosternum, heavy orange; mesosternum and metasternum, heavy golden-yellow. HEAD mostly occupied by large black eyes, in the front part of each of which is a white silvery spot. PALPI orange. TONGUE distinct, spiral, yellow, 3-16 of an inch.

The male differs from the female in being somewhat smaller, having the fringe brown-golden; the abdomen, above of a lighter steel-blue, inclining to a bronze, and beneath of a more intense golden-yellow; hairs of the tail of a steel-blue color halfway from the base, and the remaining of paler orange. In a word, he is of a lighter color than the female.

The larva is whitish, hairy, head brown; length 9-10 inch and diameter 1-8 of an inch.

McPherson, Nebraska, and, accompanied by an escort of two companies of U. S. Cavalry, proceeded to the Niobrara, and worked in that country for several weeks. Owing to hostile Indians, the explorations of the party here were attended with much difficulty and danger, but were on the whole quite successful. Many new animals were discovered, and ample material secured for a full investigation of those previously known from that region.

A second expedition was made in August from Fort Bridger, Wyoming, and large collections of Eocene fossil vertebrates were obtained, especially of the *Dinocerata*, *Quadrumana* and *Cheiroptera*, which had first been brought to light by the researches of the party in previous years. A third trip was made in September to the Tertiary beds of Idaho and Oregon, where some interesting discoveries were made. The party went from Oregon to San Francisco by sea, narrowly escaping shipwreck, and then returned east by rail. On the way, short visits were made to localities in Colorado and Kansas, to complete investigations begun last year. The expedition as a whole was very successful, not merely on account of the large number of new animals discovered, but also on account of the extensive collections made to complete the study of those previously found. All of the collections secured are now in the museum of Yale College.

MICROSCOPY.

A NEW SECTION CUTTER.—Prof. T. D. Biscoe has contrived a new section cutter which is principally adapted for preparing sections of soft vegetable tissues and organs, such as leaves, buds, etc. It consists essentially of a large glass stage-plate upon which the object is fastened, and a movable frame to slide upon this, carrying a razor blade at an adjustable distance from the plate. This apparatus cuts sections of objects while they are under observation on the stage of the microscope, under powers as high as the $\frac{2}{3}$ inch (× 80); and with it Prof. Biscoe has been able to cut series of fifteen consecutive sections, each one of which was perfect and the average thickness of which was $\frac{1}{8000}$ inch. The following is his description of the contrivance.

"Fig. 41 is a plate that fits on to the stage of the microscope with a tight friction, yet so that it has movements of an inch or more in any direction, so that the object can be brought into the field of view; *a* is a glass plate held in place by the two pieces of wood with screws on the right and left; *b* is the wooden base of the affair with an oval opening for the illuminating apparatus to come up; this wooden base being covered on the inner or upper side with velvet to make smooth the friction on the under side of the stage. For use with a mechanical stage this arrangement is modified and much simplified, the large glass plate being merely attached to the stage, whose screw movements enable the object to be brought into the field of view. On the middle of the upper side of the glass plate are cemented four strips of glass as shown, just far enough apart to take in a common glass slide which is held in place by a couple of wedges of common sheet brass; and on the middle of a slide is fastened the object to be cut, either with gum arabic or sometimes with collodion. For holding hard objects like wood the arrangements are not yet quite perfected, but no special difficulty is expected.

Fig. 41.

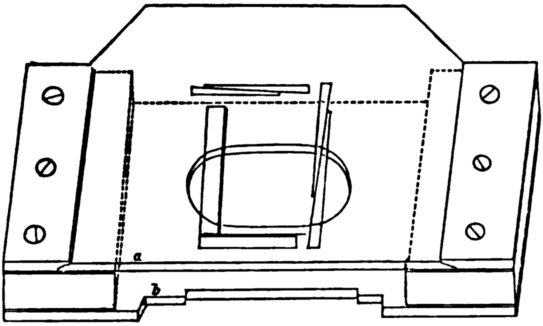


Fig. 42 gives a perspective view of the triangular wooden frame that holds a razor blade, *r*, whose edge and back come down lower than the rest of the frame. By means of the three screws with graduated heads the whole frame, razor and all, is raised or lowered from the glass plate (*a*, Fig. 41) on which the triangle rests and slides with these three screws as its feet. These three supporting screws are cut with a thread that counts forty to the inch; the screw head is divided into one hundred equal parts, and can be moved without much difficulty through half of one division, giving a vertical motion of $\frac{1}{8000}$ inch to the cutting edge.

Fig. 43 is a large view of one of the screws, with its indicator. The indicator may be a simple pin set in the wooden frame, but is more convenient if made movable around the axis of the screws, so that when the razor is returned after sharpening they may be all turned around to the 0 of their respective screws and therefore all read alike while the successive cuts are being made. On the side of the indicators are scales which show how many complete revolutions of the screws have been made. These indicators should move quite stiffly, so as not to be accidentally misplaced when turning the screw heads.

With the hands upon the triangle and the eye at the microscope tube, the razor can be moved so that its edge shall either make a drawing cut or push straight through the object like a chisel, according as either method or any gradation between them suits best the nature of the substance cut. Thus perfectly even slices can be cut, and it is quite easy to take them in consecutive order even when called off in the midst of the work and compelled to wait half an hour before resuming it. It is a luxury to take off slice after slice and know that there is no danger of losing just the slices you want especially to see. The object is kept wet with glycerine, and just as the razor begins to cut, a drop of glycerine is placed on its edge in which the slice floats without sticking; though care must be taken in the case of very thin and small sections not to lose them in a large drop of glycerine in which they would be found with great difficulty. By this method slices $\frac{1}{8000}$ of an inch in thickness, or rather in thinness, can be all worked out nicely, though before it was adopted such thin slices were all

Fig. 42.

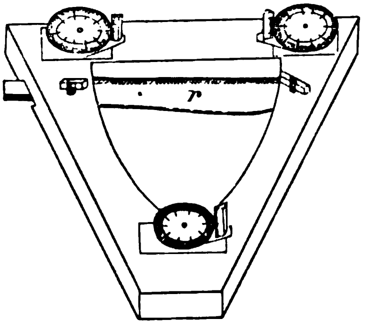
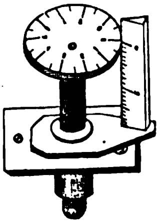


Fig. 43.



torn, so as to be unrecognizable. Whether a blade can be made to cut any thinner than that has not been tried; but it may be remarked that the first razor blade used gave out at $\frac{1}{2400}$ inch thick, and would not take an edge capable of cutting finer than that."

NOTES.

After twenty-seven years of unremitting toil for the advancement, the exaltation and free spread of science in this country, the land of his adoption, Louis Agassiz died, in the ripeness of his years, Dec. 14, aged sixty-six. It is not the time now to estimate Professor Agassiz's scientific attainments and compare him with his contemporaries, but to mourn the loss of one whose profound learning and genius for original research; whose organizing abilities, courageous adherence to the dictates of his conscience when matters of scientific faith were at stake; whose persuasive eloquence, rare personal magnetism, conspicuous enthusiasm, and untiring industry which, though it shortened his life, intensified its value, made him one of the remarkable men of the century.

A student and friend of Humboldt and Cuvier, and enjoying the instructions of Oken, Tiedemann and others, he certainly had wonderful advantages, and by his native genius and sturdy industry made the most of them, his reputation being more than European before he was thirty years of age. At the age of thirty-nine he came to this country, travelled extensively, and extended his glacial theory to include both hemispheres. Here he began to build up the Museum of Comparative Zoology, his singleness of purpose, rare personal qualities and disinterested zeal, winning him friends and means for carrying on that vast establishment. Meanwhile he travelled and lectured over the country; everywhere by his native unaffected eloquence winning men to a just appreciation of the objects and needs of science, and elevating and dignifying the pursuit of knowledge for its own sake. He was an admirable teacher, and introduced new methods of studying zoology. He gathered about him a number of young men, some of whom were associated with him in the preparation of the material for his great work, "Contributions to the Natural History of the United States;" and so powerful was his influence over his students that he may be said to have founded a school in natural history, based on the spirit of Cuvier, who moulded Agassiz himself in his student days.

Then came his Brazilian journey, with the immense zoological treasures accruing. Hardly resting from this exploration he organized the Hassler Expedition around the continent of South America, under the auspices of the Coast Survey, and recuperated his shattered health on that long voyage. Finally, he established, with the aid of its liberal founder, the Anderson School of Natural History, and it was there in his disinterested labors in behalf of improved methods of teaching in our higher and normal schools that he undoubtedly overworked himself and lost the strength to resist the strain of duties and cares that multiplied during the succeeding autumn.

He died literally in the harness; full of plans for the development of his great museum, for the enlargement and full success of the Anderson School at Penekese Island, meanwhile doing original work at the museum, writing a course of articles for the "Atlantic Monthly," and preparing some papers for this journal; all this, while performing his college duties in the lecture rooms and laboratories of the museum, with a course of popular lectures at Washington on his hands, and meanwhile not unmindful of the calls of social life.

Professor Agassiz was perhaps the most widely known and popular man in the United States. In his death it may be said that science has lost one of its most gifted followers, and humanity, in his long devotion to all that tends to elevate the race, one of its best types.

It will be seen by the following letter, dated San Francisco, Cal., Dec. 2, 1873, from Mr. W. H. Dall, that the explorations of which he has charge have been quite successful:—

"We have had a very successful season, though the spring was a very late one, and have accomplished more than I dared to hope at first. Our work lay in the islands between Attu and the Shumagins. We have visited nearly every point of interest in the Aleutian chain, including Attu, Kyska, Amchitka, Adakh, Atka, Four Craters, Bogosloff, Unalashka and the Shumagins, correcting the astronomical positions, variation of the compass, general hydrography, etc. We surveyed a harbor for the landing of one end of the Japan cable—if they take it that way—on the island of Kyska. We made some interesting soundings in Behring Sea, showing great depths of water in the western part of it, with a bottom of Globigerina ooze, our deepest cast giving about 1200 fathoms without bottom. We disproved the existence of the celebrated Bogosloff reef, finding 800 fathoms without bottom where it is laid down on the chart. We found the magnetic variation to be less easterly than when the last observations were taken. During our leisure natural history was not neglected, and we now have a magnificent geographical collection, especially in marine invertebrates. In birds, too, we did very well, and especially in prehistoric relics. We found no Asiatic influence in the western islands but a more predominating Arctic type of fauna and flora as we went west. We got several hundred wood carvings from caves, about three hundred bone and stone implements and thirty-six prehistoric crania and some later ones.

BOOKS RECEIVED.

Half-hours with the Microscope. By Edwin Lankester. 12mo, pp. 180. 9 pl. G. P. Putnam's Sons. New York, 1874.

Schriften der koniglicken physikalisch-okonomischen Gesellschaft zu Konigsberg. 4to. Jahrgang 13, Abthellung 2, Konigsberg, 1872.

Archiv fur Anthropologie. 4to. Bd. vi. Heft 1 and 2. Braunschweig.

Memoires de la Societe de Physique et d'Histoire Naturelle de Geneve. 4to. T 22. Geneve, 1872.

Bulletin de la Societe Imperiale des Naturalistes de Moscou. 8vo. 1873, No. 1. Moscou, 1873.

Bericht uber die Thatigkeit der St. Gallischen naturwissenschaftlichen Gesellschaft wahrend des Vereinsjahres 1871-72. 8vo. St. Gallen, 1873.

Transactions of the Edinburgh Geological Society. 8vo, Vol. ii, Pt. ii. Edinburgh, 1873.

Tillæg til Aarboger for Nordisk Oldkyndighed og Historie. Aarang 1871, Aarang 1872. (Udgivet af det kongelige Nordiske Oldskrift-selskab. 8vo. Kjobenhavn, 1871, 1872

Memoires de la Societe Royale des Antiquaires du Nord. 8vo, 1872. Copenhague.

On the Origin and Metamorphoses of Insects. By Sir John Lubbock. 12mo, pp. 108. 6 plates. 63 woodcuts. London, 1874. McMillan & Co.

An Investigation concerning the Mechanism of the Ossicles of Hearing and the Membrane of the Round Window. By Charles H. Burnett. 8vo, pp. 13. New York, 1872.

Catalogue of the Lower Silurian Fossils, Cincinnati Group, found at Cincinnati and Vicinity, within a range of forty or fifty miles. By U. P. James. 8vo, pp. 14. Cincinnati, Sept., 1871.

Bulletin of the American Geographical Society. Nov. 11, 1873.

Supplementary and Final Report of a Geological Reconnoissance of the State of Louisiana, made under the auspices of the New Orleans Academy of Sciences and of the Bureau of Immigration of the State of Louisiana in May and June, 1869. By Eugene W. Hilgard. 8vo, pp. 44. New Orleans, 1873.

Annual Report of the Secretary of the Interior on the Operations of the Department for the year 1873. 8vo, pp 36. Washington, 1873.

Twenty-third Annual Report of the Regents of the University of the State of New York on the Condition of the State Cabinet of Natural History and the Historical and Antiquarian Collection annexed thereto. 8vo, vol., pp. 252, 14 plates. Albany, 1873.

Twenty-fourth Annual Report on the New York State Museum of Natural History by the Regents of the University of the State of New York. 8vo, vol., pp. 252. 8 plates. Albany, 1872.

Twenty-fifth Annual Report on the N. Y. State Museum of Natural History by the Regents of the University of the State of New York. 8vo, pp. 123. 2 plates. Albany, 1873.

Principles of Animal Mechanics. By Samuel Haughton. 8vo, vol., pp. 495. 111 Illustrations. London, 1873 Longmans & Co.

Zoological Record for 1871. 8vo, vol., pp. 496. London, 1873. Van Voorst.

Revisions of the Extra-tropical North American Species of the Genera Lupinus, Potentilla and Œnothera. By Sereno Watson. (Proc. Am. Acad. Arts and Sciences, vol. viii, May 13, 1873).

Sitzungsberichte der physikalisch-medicinischen Societat zu Erlangen. 8vo. Heft 5. Erlangen, 1873.

Contributions to the Extinct Vertebrate Fauna of the Western Territories. By Joseph Leidy. 4to, pp. 358. 37 plates. Washington, 1873. Hayden's Geological Survey U. S. Territories.

The Birds of North America drawn from life and uniformly reduced to one-quarter their Natural Size. By Theodore Jasper. Large 4to. Issued in parts. 4 parts received.

Hepaticæ Boreali Americanæ. By Coe F. Austin. 8vo, pp. 48. Closter, N. J., 1873.

Annual Report of the Trustees of the Museum of Comparative Zoology at Harvard College, in Cambridge, together with the Report of the Director for 1872. 8vo, pp. 36. Boston, 1873.

Land and Water. London, Nov. 1-Dec. 20, 1873.

The Field. London, Nov. 1-Dec. 20, 1873.

The Academy. London, Nov. 1-Dec. 15, 1873.

Science Gossip. London, Nov., Dec , 1873.

Revue Scientifique. Paris, Nov. 1-Dec. 20, 1873.

Entomologist's Monthly Magazine. London, Nov., Dec., 1873.

Horticulturist. New York, Nov., Dec., 1873.

Proceedings of the Academy of Natural Science of Philadelphia. Part ii. Mar., Sept., 1873.

Journal of Botany. London, Nov., 1873.

Grevillea. London, September, 1873.

Forest and Stream. New York, Jan. 1, 1874.

Popular Science Monthly. New York, Dec., 1873.

Nature. London, Nov. 6-Dec. 4, 1873.

American Bee Journal. Chicago, Nov., 1873.

Naturaliste Canadien. Quebec, Nov., Dec. '73.

Canadian Entomologist. Vol. v, Nos. 10 and 11. London, 1873.

Proceedings and Transactions of the Nova Scotian Institute of Natural Science. Halifax. Vol. iii, pt 3, 1872-73.

American Journal of Science and Arts. New Haven, Dec., 1873.

Gardener's Monthly. Philadelphia, Dec., 1873.

THE

AMERICAN NATURALIST.

Vol. VIII.—FEBRUARY, 1874.—No. 2.

THE YELLOWSTONE NATIONAL PARK.

BY THEO. B. COMSTOCK, B.S.

I. ITS SCIENTIFIC VALUE.

It is now generally understood that a bill was passed by the 41st Congress, by which the tract of land known as the "Yellowstone National Park" was "reserved and withdrawn from settlement, occupancy or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring-ground for the *benefit* and enjoyment of the people."

The writer of this article, having spent some weeks during the past summer in the study of the geological features of this remarkable region, has visited all its points of interest, and collected much material for the elaboration of a report, which is now in course of preparation. Dr. Hayden has already led two well equipped expeditions into this country,[*] while smaller parties have gathered more or less valuable material concerning the phenomena there exhibited.[†] The leaders of all of these expeditions

---

[*] See Geological Survey of Montana, etc, 1871; also Geological Survey of Montana, Idaho, Wyoming and Utah, 1872.

[†] In this connection it is but just to mention the names of Cook and Folsom, who ascended the Yellowstone valley and visited the Madison River geysers in 1869; Lieut. G. C. Doane, 2nd U. S. Cavalry (accompanying Gen. Washburn) in 1870, who reported briefly to Gen. Hancock; and Capts. Barlow and Heap. U. S. Engineer Corps, whose report to Gen. Sheridan was published in 1872. Hon. N. P. Langford, ex-governor of Montana, now superintendent of the park, has also published a number of interesting popular articles concerning its marvels.

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

seem to have been satisfied with the conclusion reached by Colonel Wm. F. Raynolds, who, attempting to reach this region from the head waters of Wind River without success, decided that such a route was wholly impracticable. Since 1859, the date of Raynolds' expedition, all explorers have taken it for granted that the sources of Wind River can only be reached from the head waters of Yellowstone River, by making a *détour* so as to cross the Wind River mountains through Union pass. Impressed with this idea, entrance has heretofore been made from the northward by way of forts Ellis and Bozeman in Montana, with the one exception of a portion of Dr. Hayden's command of last year, which entered by ascending the valley of Snake River, under the guidance of Mr. James Stevenson. It was natural, therefore, that much interest should attach to the results attained by an expedition, which took the field during the past summer, with the expressed intention of solving as much as possible of the mystery overhanging the structure of the unexplored territory adjacent to the park on the south and east.[*] The northwestern Wyoming expedition, under the command of Capt. W. A. Jones, Chief Engineer of the Department of the Platte, after an extended tour of exploration among the complicated mountain ridges of the Wind River drainage, entered the park by a new route. Ascending one of the forks of the Stinking Water[†] to its source in the high and rugged volcanic wall on the east of Yellowstone Lake, a pass was discovered through which the pack-train was guided safely, but with considerable difficulty. This route, though in some respects preferable to the present circuitous way of entering the park, is not destined to be made available to tourists, owing to the engineering difficulties to be surmounted, and the comparatively slight saving in the distance. Upon the return of the expedition, however, a very practicable entrance was discovered, by way of the head of Wind River, from the southward. Through this new pass, which Capt. Jones has appropriately named *Tŏ-gō-tĕ*,* after our Shoshone guide, a railroad may be constructed with little difficulty to connect with the Union Pacific at Rawlins, *which would save to tourists from the east at least five hundred miles of travel in each direction.* This would render the park and the Montana settlements readily accessible, and unlock the rich mineral deposits of the Wind River valley and the Sweetwater (Wyoming) mining region. Here also a fine agricultural country is awaiting development, and already herds of excellent cattle are to be seen grazing in the rich pastures of the smaller valleys.

---

[*] The interesting geological results of this expedition are enumerated in an article by the writer, on the Geology of Western Wyoming, in the Amer. Jour. of Sci., Dec., 1873.

[†] I have elsewhere referred to the frequent and confusing repetition of geographical names in the west, for which no remedy seems available. I am here obliged to note that the Stinking Water *River*, to which I now allude, is an important tributary of the Big Horn, and *not* the Stinking Water *Creek* so often mentioned by Hayden, which is a tributary of Jefferson Fork of the Missouri. Stinking Water *River* is in Wyoming, Stinking Water *Creek* in Montana

While upon this subject I would ask if some measures cannot be adopted to prevent this annoying confusion of names. Why would it not be wise to substitute, as far as possible, in future maps, the more attractive Indian names for the most *abused* of those now in use? Certainly the majority of the Indian names are much preferable to their English translations.

In order to show the extent of this polynomial evil I have compiled the following list of the names of streams, which occur more than once within a distance of three hundred miles of Yellowstone Lake, all within the limits of Wyoming, Montana, Idaho, and northern Utah, but the majority are found within a radius of one hundred miles of the Park: Henry's Fork 2, Smith's Fork 3, Lake Fork 2, Bear River 2, White River 3, Powder River 2, John Day's River 2, Téton River 2, Snake River 2, Sage Creek 5, Cottonwood 3, Muddy 5, Dry Creek 4, Clear Creek 2, Sour Creek 2, Deep Creek 2, Spring Creek 3, Beaver Creek 3, Elk Creek 3, Deer Creek 2, Black-tailed Deer Creek 2, Bitter Root Creek 2, Yellow Water Creek 2, Stinking Water 2. Thus we have sixty-two *distinct* but not widely separated streams designated by the use of only twenty-four names.

While traversing that portion of this region now reserved for the general public, embracing the greater number of the hot springs and geysers, I was very deeply impressed with a sense of the immense amount of time and labor which must be spent in investigating the various productions and phenomena of the park, ere we can unravel its past history or fully interpret its present manifestations. By a most fortunate, though quite accidental disposition of my time, I was enabled to pass through the most interesting portion of these wonders in such a manner as to witness and note a large number of the most striking manifestations in a comparatively short space of time. And yet when I say that I could have remained for weeks in the neighborhood of a single geyser or spring, watching closely its daily and hourly pulsations and eruptions, studying its history, and marking its effects without feeling anything more forcibly than my own ignorance, it will readily be seen that my time was all too brief for the performance of the work as I desired.

---

* In indicating the pronunciation of Indian words I have adopted, as nearly as possible with ordinary type, the admirable and comprehensive system of Dr. C. H. Berendt, as explained in his paper entitled "Analytical Alphabet for the Mexican and Central American Languages," published by the American Ethnological Society, New York, 1869.

It should be noticed that the "*g*" in this word has the sound of the *guttural* "*j*" of Dr. Berendt, which is the equivalent of *ch* in the German *buch*.

Much has already been said concerning the benefits to be derived by science from the setting aside of this tract of land and the protection of its natural features. In fact this was one of the inducements offered for the passage of the bill in both houses of Congress. Dr. Hayden, in speaking of this bill says, "I believe it will mark an era in the popular advancement of scientific thought not only in this country, but throughout the civilized world. . . . . . . This noble deed may be regarded as a tribute from our legislators to science, and the gratitude of the nation and of men of science in all parts of the world is due them for this munificent donation." *

In this paper I propose to offer some suggestions based upon my own experience in the Yellowstone country and adjacent portions of the Rocky Mountains, tending to show some of the benefits which, in my opinion, may be made to accrue to science by the proper use of this grant. The tide of emigration, now fairly started on its westward course, is daily seeking new fields for conquest, and with the abundant treasures stored by nature in the hills and valleys surrounding our park, there can be no question that this territory is destined to become a scene of great activity at no very distant day. The Wind River valley, the greater portion of which must be traversed by any highway entering the park from this direction, is remarkably rich in mineral wealth so exposed as to make its working a problem of the simplest nature.

In a previous paper† I have briefly alluded to this fact in connection with a discussion of the prominent geological features of this highly interesting section. It is also highly probable that the once vigorous gold mining interests of South Pass and vicinity would be revived by the introduction of sufficient capital, while the markets thus produced would stimulate agriculture in a region very favorable for its successful prosecution. Nor can I doubt that the immense deposits of iron, coal, and even oil, will yet be found to be of the very greatest economic value.

In a word, it is my humble opinion that the territories adjacent to the national park will ere long be among the most thickly settled portions of the west, and that within the next decade or two

---

* Geological Survey of Montana and adjacent Territory, 1871, p. 162.

† On the Geology of Western Wyoming, Amer. Jour. Sci. Dec., 1873.

we may confidently hope to add to our banner another star representing a part of this region. The Montana mining settlements are already a fixed fact, and the inhabitants of the whole area alluded to, ever alive to their own interests, are rapidly developing the capacities of their soil. Dr. Cyrus Thomas, in his valuable and very interesting report to Dr. Hayden in 1871, says* "It is only after a careful examination of a vast number of experiments made in New Mexico, Colorado, Wyoming, Utah, etc., that I am forced to acknowledge what I before did not believe, viz: *that wherever there is soil in these regions, it is rich in the primary elements of fertility.*" Again he remarks,† "As a final illustration, I would refer to the efforts of the Mormons on the Rio Virgin, along the Arizonian border, where I might truly say, amid basaltic hills and drifting sands the desert is being turned into a blooming garden. Perhaps a more desolate looking region than the vicinity of St. George could scarcely have been selected; yet the application of water shows that here, as elsewhere, the soil is rich in the mineral elements necessary to fertility."

Much of the area to which I have referred requires no irrigation, while the greater portion of the remainder is very favorably situated for the easy application of water. On the plains at some distance from the mountains this process will be much more difficult on many accounts, and yet I do not doubt that even in such situations it will be attended with success when systematically practised.‡

I have thus seemingly digressed from my subject in order to show that the reservation of 3,600 square miles of that portion of this area embracing its most remarkable features was well timed, in consideration of the destructive tendencies of civilization.

The following are extracts from the report of the Committee on the Public Lands, concerning the bill providing for this reservation: "Persons are now waiting for the spring to open to enter in and take possession of these remarkable curiosities; to make merchandise of these beautiful specimens; to fence in these rare wonders, so as to charge visitors a fee, as is now done at Niagara Falls, for the sight of that which ought to be as free as air or water.

---

* Geological Survey of Wyoming and contiguous territory, 1870, p. 194. Washington, 1871.

† *Ibid.*, p. 195.

‡ I take pleasure in referring the reader to the valuable reports of Dr. Thomas, which have been published with those of Dr Hayden, where the whole subject of irrigation is fully discussed.

. . . .

If this bill fails to become a law this session, the vandals, who are now waiting to enter into this wonder-land will, in a single season, despoil, beyond recovery, these remarkable curiosities, which have required all the cunning skill of nature thousands of years to prepare." If such were the danger then, how much greater would it be when the surrounding country had become thickly populated.

Having thus proven the wisdom of this liberal appropriation, let us turn our attention to a brief review of the main features of the park in its present wild condition.

First, as regards the evidences of waning subterranean heat, so abundantly manifested within the limits of this reservation. It is a remarkable fact that the springs in different localities are widely dissimilar in many respects, and even those in the same locality often differ as greatly from each other in some of their characteristics. The White Mountain hot springs of Gardiner's River are a noteworthy example of this, and did there exist no other reason for the formation of a park in this region, the fact that here the successive steps in the history of the ancient volcanic action are so clearly portrayed is alone sufficient ground for their protection. I venture to say that nowhere in our country, not even in the truly wonderful cañon of the Colorado, is so much of geological history crowded into such narrow limits, as in this portion of the Yellowstone basin. Nowhere in the world, I had almost said, is there to be found such an infinite variety with so small an expenditure of material. The area within which all this is comprised is much less than ten square miles. Some of the most interesting products are so delicate, and many of them are formed in situations so peculiar, that frequently the work of years might easily be demolished in a very few seconds. It is true that in many cases spoliation may be rectified, but there are numerous formations which have been and are now progressing so slowly, that the work of accumulation can barely keep pace with the destructive effects of natural erosion.

And yet this remarkable section furnishes but a small portion of the attractions of the park to the scientific observer. Hot and cold springs, mud volcanoes, fumaroles, solfataras and geysers, rapids, waterfalls and torrents, deep-cut cañons and craggy peaks abound in every direction; lakes, gorges and cataracts, surprise one almost at every turn, and the whole is situated at a point where "the grand Rocky Mountain system culminates in a knot of peaks and ranges enclosing the most remarkable lake basin in the world. From this point radiate the chief mountain ranges, and three of the longest rivers of the continent, the Missouri, the Columbia and the Colorado."[*]

These being preserved by act of Congress, the earnest student of nature will always find an abundance of fresh matter for research in nearly every department of science. Here he will find ready to his hands a laboratory of physics in which he may observe on a large scale the action of the various forces of attraction and repulsion, and new illustrations of the correlation and conservation of energy cannot fail to attract his attention. He will find the laws of crystallization exemplified in forms novel and instructive, and will doubtless witness many new and varied phenomena of heat, light and electricity.[†]

The chemist will interest himself in problems of analysis and synthesis, in the processes of evaporation, condensation and solution, and the chemical changes incident thereto. To the botanist and the vegetable physiologist, the field is open for observation and wide experimentation, but there exists, even at this great altitude, a storehouse of facts bearing upon the distribution and fertilization of plants, and the almost indefinite related subjects. The zoölogist and the student of comparative anatomy may also hope for rich rewards, in but partially explored fields, and the meteorologist, astronomer, artist and physician, may each find here full employment for his peculiar talent. Speaking from a geological standpoint, I can, from my own experience, promise the enthusiastic student of our earth's history a view at once so complete and so overwhelming as to enchain his whole attention.

---

[*] Wonders of the Yellowstone, edited by James Richardson. New York, Scribner, Armstrong & Co., 1873.

[†] In the Geological Survey of Montana, Idaho, Wyoming and Utah, 1872, p. 121. Dr. A. C. Peale, mineralogist of Hayden's expedition of that year, notices a peculiar electrical phenomenon witnessed, or rather, experienced, by himself in company with two others of the party while ascending a peak near the Gardiner's River springs.

At page 807 of the same volume, Mr. Henry Gannett thus describes this "singular experience." "A thunder-shower was approaching as we neared the summit of the mountain. I was above the others of the party, and when about fifty feet below the summit the electric current began to pass through my body. At first I felt nothing, but heard a crackling noise, similar to a rapid discharge of sparks from a friction machine. Immediately after, I began to feel a tingling or pricking sensation in my head and the ends of my fingers, which, as well as the noise, increased rapidly, until, when I reached the top, the noise, which had not changed its character, was deafening, and my hair stood completely on end, while the tingling, pricking sensation was absolutely painful. Taking off my hat partially relieved it. I started down again, and met the others twenty-five or thirty feet below the summit. They were affected similarly, bnt in a less degree. One of them attempted to go to the top, but had proceeded but a few feet when he received quite a severe shock, which felled him as if he had stumbled. We then returned down the mountain about three hundred feet, and at this point we still heard and felt the electricity.

Secondly, I consider that the Yellowstone National Park can be made a really valuable laboratory and conservatory of science at little cost and without detriment to any of the interests before mentioned.

Momentous questions are now agitating the scientific world, calling for experiment and observation which are daily becoming less possible, owing in a great measure to the obliterating influences of modern civilization. Thus it would almost seem that the present difficulties in the way of the solution of many questions, bearing upon the process of natural selection, will soon become insurmountable if some means are not employed to render more practicable the study of animals in a state of nature.

I have not space to treat this subject as it deserves, but for this and other reasons, I desire to call attention to what appears to me one of the most important uses to which the park can be put, viz.: *the preservation from extinction of at least the characteristic mammals and birds of the west, as far as they can be domiciled in this section.*[*] The astonishing drain upon the American bison caused by the very extensive use of the buffalo robe, has led to the almost reckless waste of the life of an animal of the greatest value. I am not disposed to question the right of a nation to decide as to whether it will utilize its wild productions or supply their waste by the laborious and costly processes of civilization. We are now concerned only with the question of extinction and its relation to our researches.

If the reader will bear with me for a moment, while I bring to his notice a very few of the facts in the case, I am persuaded that he will agree with me in the statement that unless prompt and vigorous measures are instituted to check the wholesale slaughter, now in progress in our western wilds, the *zoölogical record of to-day must rapidly pass into the domain of the palæontologist.* I select for my purpose only the more prominent of the many examples which might be given of animals in the west, which are rapidly becoming extinct through the agency of man—directly or indirectly at the hand of *civilized* man.

---

[*] I say nothing of the reptiles, amphibians and fishes, principally because they are in much less danger of extinction, but also on account of the difficulties and disadvantages of settlement in a new region, which might result adversely.

The American bison (*Bos Americanus* Gmelin), according to Rütimeyer, is identical with *Bison priscus* of the British palæolithic or drift deposits. The European aurochs (*Bos bison* or *Bison Europæus*) cannot be *specifically* separated from the latter, (*B. priscus*), however, for it is possible to trace the gradations between them. Sir J. Lubbock asserts that "the American form of bison is the more archaic."* It is, perhaps, somewhat remarkable that an ancient genus containing forms so well suited to supply man with many of the comforts and luxuries of life, should, notwithstanding the better adaptations produced by domestication and careful breeding, still be so well represented by members in a wild state.† The aurochs is now nearly extinct, but some are found in the Carpathian Mountains and the marshy forests of Poland, while it is said to be represented by a few individuals in western Asia, in the neighborhood of Mount Caucasus. Several hundred were for a long time carefully preserved by the emperor of Russia, in the forests of Lithuania, but little is now generally known concerning them, and it is to be feared that they are there nearly or quite exterminated.

The urus (*Bos primigenius*), according to one historian‡, existed in Switzerland as late as the sixteenth century.

The American bison formerly ranged over a very large portion of this country east of the Rocky Mountains, extending even to the Atlantic, and southward into Mexico. In 1862, according to Baird, "its main range was between the upper Missouri and the Rocky Mountains, and from northern Texas and New Mexico to Great Martin Lake in latitude 64° N."§ This was equivalent to an area of 1,500,000 square miles. To-day they roam over portions of this wide region, but the great railroads seem to present impassable barriers, which cause them to be distributed in lots, as it were, between them. I believe it to be a fair estimate to allow them a present range, all told, of not more than 500,000 square miles, a reduction of one million square miles in twelve years. Granting the possible fact that the reduction in numbers may be in smaller proportion, and allowing for errors in the calculation, *there can be little doubt that in the next ten years this race will become extinct*, at the present rate of destruction.

---

* Prehistoric Times, 1869, p. 306.

† Besides the American bison and the aurochs there are now existing wild in India, the buffalo (*Bos bubalus* Linn), and the arnee (*B. arni* Shaw); in southern Africa, the Cape buffalo (*B. Caffer* Sparm.); in central Asia, the yak, or grunting ox (*B. grunniens* Pall.); and in the Malayan Archipelago, the banteng (*B. Sondaiens*).

‡ Heberstain.

§ Dana, Manual of Geology, 2d ed., p. 580.

The wolverine (*Gulo luscus*) also represents an ancient type, found in the bone caves of England and Belgium. It is liable to rapid extinction on account of the value of its fur.

The Rocky Mountain grizzly bear (*Ursus horribilis* Ord.) is found by Mr. Buck* to be osteologically identical with remains occurring in ancient British deposits of Post-tertiary age. This species is, perhaps, not yet scarce enough to need protection, as it is mainly confined to mountainous regions, and the flesh is not greatly in demand. It is a question, however, whether its skin will not be more frequently sought in consequence of the disappearance of the bison, or buffalo.

The American beaver (*Castor Canadensis*), hunted alike for its skin and its anti-civilization propensities, is a distant relative of *Castoroides Ohiensis* of the American Post-tertiary. Its limits, as with other animals, have been much curtailed by the advance of civilized man. It is worthy of preservation for its peculiar habits, which need no description.

The tailless hare, or lagomys, represented in the Rocky Mountain region by the little chief hare (*L. princeps* Rich), "a genus now confined to the Himalayas, Siberia, and the colder regions of North America, has been identified by Prof. Owen among the bones from Kent's Cavern, and by Dr. Falconer among those from the Brixham Cave."†

The American moose (*Alce Americanus*) the equivalent of the Norway elk (now all but extinct in Europe) is another living representative of the Post-tertiary period. Though, at present, quite abundant in this country, it is doubtful whether it can long withstand the assaults of the hunter, even with the existence of stringent game laws. The same remark will apply with even greater force to the black-tail (*Cervus Columbianus* Rich), and the cotton tailed deer (*C. leucurus* Douglas), the prong-horn antelope (*Antilocapra Americana* Ord), and particularly to the mule deer (*Cervus macrotis* Say) which is occasionally met in this region. I might also add, with equal propriety, the mountain sheep or big horn (*Ovis montana* Cuvier) and the various *game* members of the Rodentia, as well as, in fact, all the *game birds* of this region, including the ducks, geese, grouse, etc.

---

* Geological Journal, 1868.

† Sir J. Lubbock, Prehistoric Times, 1869, p. 307.

The mallard (*Anas boschas* Linn.) is the only bird of antiquity included in this fauna, remains of this species having been taken from the principal lake dwellings of Switzerland.

There are numerous other animals which might be included in this protective scheme, without interfering in the least with any plans for the best improvement of the park, and, what is, perhaps, of as much importance to our practical friends to whose influence we must look for its furtherance, without any serious addition to the burden of expense.* All of these animals are more or less

---

*The following *partial* list comprises only the more important of the mammals and birds observed by myself during the past summer (exclusive of those already mentioned), with some few additions from the report of Mr. C. H. Merriam, Zoologist of the Snake River Division of Dr. Hayden's expedition of 1872, in order to include a portion of the fauna of Idaho and Montana:—

MAMMALS.

Felis concolor Linn.—Cougar; Puma; Catamount.
Canis occidentalis, { var. *griseo albus* Rich.—White and Gray Wolf.
{ var. *nubilis* Say.—Dusky Wolf.
Canis latrans Say.—Coyote;—Prairie Wolf.
Putorius pusillus Aud. and Bach.—Least Weasel.
Putorius Richardsonii Bonap.—Little Ermine.
Lutra Californica Gray.—California Otter.
Mephitis mephitica, var. *occidentalis* Baird.—California Skunk.
Mephitis bicolor Gray.—Little Striped Skunk.
Taxidea Americana Waterh.—American Badger.
Procyon Hermandez Wagler.—California Raccoon.
Ursus Americanus Pallas.—Black Bear.
Sciurus Hudsonius Pallas.—Red Squirrel; Chickaree.
Sciurus Richardsonii Bach.—Richardson's Squirrel.
Pteromys alpinus Rich.—Rocky Mountain Flying Squirrel.
Tamias quadrivittatus Rich.—Missouri Striped Squirrel.
Spermophilus lateralis Rich.—Say's Striped Squirrel.
Spermophilus Townsendii Bach.—Townsend's Spermophile.
Cynomys Ludovicianus Baird.—Prairie Dog.
Cynomys Gunnisonii Baird.—Short Tailed Prairie Dog.
Arctomys flaviventer Bach.—Yellow-footed Marmot.
Fiber zibethicus Cuvier.—Muskrat.
Erithizon epixanthus Brandt.—Yellow-haired Porcupine.
Lepus Townsendii Bach.—Jackass Rabbit.
Lepus artemisia Bach.—Sage Hare.
Lepus sylvaticus Bach.—Gray Rabbit.
Lepus Bairdii Hayden.—Baird's Rabbit. ("One very curious fact relating to *Lepus Bairdii* is that all the males have teats and take part in suckling the young."—C. H. MERRIAM.) I have never met with this species myself.
Cervus Canadensis Ercl.—American Elk; Wapiti.

BIRDS.

My geological duties were too pressing to allow of any ornithological work; hence this meagre list of Birds:

Falco columbarius Linn.—Pigeon Hawk.
Falco polyagrus Cassin.—Prairie Hawk.
Tinnunculus sparverius Vieill.—Sparrow Hawk.
Accipiter Mexicanus Sw.—Blue-backed Hawk.

liable to rapid extermination by reason of their value to man. None of them need be considered dangerous when unmolested, and, in fact, the same may be said of the whole fauna of this region, without exception.* It is only when wounded, or pressed by the severest hunger that any one with ordinary presence of mind need fear to meet the most powerful of these brutes, entirely unarmed.†

Thirdly, we have here, and may retain without the necessity of protective measures, a large number of invertebrate animals whose habits are little known, and whose structure has scarcely been investigated, and this remark will apply as well to the lower members of the vertebrate series. There is, perhaps, much reason to look for a *peculiar* fauna in this restricted region, both on account of its altitude and its comparatively isolated position, as well as the severity of the climate at certain seasons of the year.‡

Buteo calurus Cassin.—Red-tailed Black Hawk.
Pandion Carolinensis Bonap.—Fish Hawk; Osprey.
Athene hypogæa Bonap.—Burrowing Owl; Prairie Owl.
Picus Harrisii Aud.—Harris' Woodpecker.
Picoides dorsalis Baird.—Striped Three-toed Woodpecker.
Sphyropicus ruber Baird.—Red-breasted Woodpecker.
Melanerpes erythrocephalus Sw.—Red-headed Woodpecker.
Ceryle alcyon Bole.—Belted Kingfisher.
Turdus migratorius Linn.—Robin.
Sialia arctica Sw.—Rocky Mountain Bluebird.
Agelaius phœniceus Vieill.—Red-winged Blackbird.
Pyranga Ludoviciana Bonap.—Louisiana Tanager.
Mimus Carolinensis Gray.—Cat Bird.
Spizella socialis Bonap.—Chipping Sparrow.
Corvus Americanus Aud.—Common Crow.
Corvus carnivorus Bart.—American Raven.
Pica Hudsonica Bonap.—Magpie.
Zenædura Carolinensis Bonap.—Carolina Dove.
Tetrao obscurus Say.—Dusky Grouse.
Centrocercus urophasianus Sw.—Sage Cock; Cock of the Plains.
Bonasa umbellus, var. *umbelloides* Baird.—Gray Mountain Grouse.
Cygnus buccinator Rich.—Trumpeter Swan.
Bernicla Canadensis Bole.—Canada Goose.
Nettion Carolinensis Baird.—Green-winged Teal.
Pelecanus erythrorhyncus Gm.—American Pelican.

*I make this statement advisedly, for, although I have repeatedly been exposed to attacks from predatory animals in this country and in Brazil, including the black, cinnamon and grizzly bears, the puma, jaguar, wolverine and wolf, and even the venomous reptiles such as the rattlesnake and the boa, I have always found them ready to run at my approach. The alligator, also, which has such a terrible reputation, is an arrant coward, and attacks man only when the chances are greatly in its favor.

† The protection of those animals which constitute the principal food of the more ferocious kinds would cause the occurrence of excessive hunger to become so very rare that no danger need result from this source.

I am aware that my ideas upon this subject are quite novel to many, but I believe them to be supported by the facts, as well as by the testimony of experience. My own observation, *by itself*, is of little value, but I have based my conclusions very largely upon the evidence of those whose wide knowledge of the habits of these animals in a state of nature best qualifies them to judge.

‡ The lowest point within the limits of the park is probably at the mouth of Gardiner's River, about 5,400 ft. above sea level, and this is quite exceptional, being on the northern boundary line of the reservation. Yellowstone Lake has an elevation of

It is interesting to observe, however, that a very large proportion of the animals here discovered belong to species of wide range, or, if more local in their distribution, they frequently represent districts far removed. But perhaps the most remarkable feature of this distribution is that we find here living, apparently under quite similar conditions, representatives of peculiarly *southern* and peculiarly *northern* types, with some representatives of *Pacific* types.* This opens to view at once a wide field for observation upon the habits and economy of a large number of the diversified group of insects.

The stridulation of insects, and the various sexual variations and appendages, may all be here studied to the very greatest advantage. I might give from my own notes upon these and other subjects, taken while deeply engaged in arduous duties of another nature, many interesting observations which, in many cases, I was absolutely *compelled* to make, so abundant was the material everywhere present.

Fourthly, there would be much to say upon many subjects connected with the botany of this region, were it not that its elucidation has been intrusted to much abler minds than mine. Pre-

---

7,800 ft., and there are numerous peaks whose altitude is nearly or quite 10,000 ft., while a number rise several hundred feet above these.

During the summer months the climate is mild and even hot in the daytime, but in clear weather the nights are very cold and frosts are not uncommon. This is due to the excessive radiation, which, during cloudy nights is, of course, much less, and the temperature consequently increased.

*The full discussion of this very interesting subject would be out of place in an article of this nature, but I cannot refrain from noticing what I believe to be the obvious explanation of this seemingly complex distribution. It must be remembered that, while this portion of country is hemmed in on all sides by high snow-clad walls, it is yet the main centre or heart of the aqueous circulation of a vast territory. The river channels of the sources of the Missouri, the Columbia, and the Colorado, cut through the otherwise impregnable rim of this basin, affording alike an outlet to the rains and melted snows, and an inlet to the insects and other animals which may by any means be forced to enter. Thus we may find, at the point from which their sources diverge, a few of the more hardy or more persecuted representatives of the lower valleys of these rivers. Were there no barriers of any kind between these points, we might expect to find whole groups of insects and the smaller animals, which had gradually moved upward and become acclimated here or even descended along the valleys of the other rivers. The facts show, however, that the representatives of distant districts now living in the Park are not thus connected in distribution with those districts. The natural conclusion, then, is that such park species are the descendants of accidentally introduced specimens which were hardy enough or fortunate enough to have completely crossed the barriers, instead of being destroyed *in transitu*. The great barrier, in this case, as remarked by Dr. Thomas, I believe to be the great plains which intervene between the head waters and the lower valleys of these great rivers, and perhaps, in one instance, the Sierra Nevada Mountains also form a barrier.

mising that Dr. C. C. Parry acted as the botanist of the northwestern Wyoming expedition of 1873, I will only add that his observations prove that the rewards of research in that department are no less promising than in other fields.

Fifthly and lastly, there is one young but active science — microscopy, — which has as yet scarcely entered this field, but which, I firmly believe, will discover within the limits of the Park most valuable treasures. The act of Congress providing for this reservation insures the preservation of the greater portion of whatever may be available for this purpose.

Among the most interesting objects for the microscope, will be found the colloidal and filamentous products of the hot springs,[*] the minute vegetable and animal life of both hot and cold springs, the animal and vegetable parasites, and the numerous crystalline deposits of the hot springs and geysers.

Yellowstone Lake, in many places near its borders, is so completely filled with a soft greenish substance in small pellets, that it is impossible to dip a cupful of the water without including hundreds of them. They are apparently of vegetable origin, but careful microscopical investigation is needed to determine their ultimate structure. Whether this green matter has anything to do with the presence of the intestinal worms (*Dibothrium cordiceps* Leidy),[†] so abundant in the trout of the lake, I cannot say, but the idea has been suggested to me from facts observed in this connection.[‡] The whole subject of intestinal parasites is extremely interesting, and this particular case is, on many accounts, more than ordinarily so. The successive stages in the development of this species, and the conditions necessary to its metamorphoses, have never been studied. I can only say that I do not regard the intestinal cavity of civilized man as one of its habitats, but more extended observation of its habits may prove the contrary.

It would be a pleasant task to continue my subject much farther, but I feel that I have written all that is needed to prove the scientific value of the Yellowstone Park. At the same time, I am confident that I have in no degree over-estimated its value to science, but, on the contrary, I have been obliged to omit mention altogether of many points which might add greatly to the interest in this section of country, for lack of space to record them.

---

[*] I use the terms *colloidal* and *filamentous* to designate peculiar growths in the boiling springs, concerning the nature of which little is known.

[†] A description of this species, with two figures of the head, will be found in Hayden's Report on Montana, etc., 1871, p. 381.

[‡] Hayden states (*ibid.*, p. 97) that these parasites are found only in the trout taken above the Upper Falls of Yellowstone River. This observation is, in the main, correct, but I have met them, *though rarely*, in those of East Fork, which leads me to suspect that they may occur in the main river below the falls. It is probable, I think, that their habitat is preëminently the lake.

If anything which I may have said shall in any way aid in developing an interest in our park, or in any of the special departments of science which can there be best prosecuted with success, I shall be well repaid for my effort.

It must be remembered, however, that at present everything in this region is in a crude state, and it will be necessary to introduce gradually the requisite appliances for work, and means for the accommodation, transportation and sustenance of those who desire to work in this field. These will all come in due time, as the avarice of man leads him to discover these demands for his commodities, and in the meantime we may congratulate ourselves that the work of *destruction* is stayed.

I do not propose here to offer any suggestions nor to put forward any plans for the furtherance of scientific investigation; my purpose is accomplished if I have succeeded in making a lucid statement of the real facts of the case. In an article to appear in the succeeding number of the NATURALIST, it is my intention to enter more fully into the subject of the best methods for the improvement of this tract.

ON THE STRUCTURE AND AFFINITIES OF THE BRONTOTHERIDÆ.[*]

PLATES I, II.

BY PROFESSOR O. C. MARSH.

THE Miocene deposits on the eastern slope of the Rocky Mountains contain the remains of a group of gigantic mammals, of much interest, which have been named by the writer, *Brontotheridæ*.[†] Although these animals are less remarkable than the

---

[*] Published in part in the Amer. Jour. of Sci., vol. vii, Jan., 1874.

[†] Amer. Jour. Sci., vol. v, p. 486, June, 1873.

Dinocerata of the Eocene,* which they seem to have replaced, they equalled them in size, and resembled them in several important features, notably in the structure of the feet, and in having the head armed with a pair of powerful horns. The general structure of the group, however, clearly indicates that they do not belong in the order *Dinocerata*, but should be placed with the Perissodactyls, in which they form a well-marked family.

The more prominent characters of this family were pointed out by the writer in describing *Brontotherium gigas* Marsh, the type species, and others had been previously mentioned by Dr. Leidy, in his descriptions of *Titanotherium Proutii*.† The skull of the latter genus is not known, but there can now be no reasonable doubt that it was furnished with horns, in some respects similar to those of *Brontotherium* (plates i and ii). The possibility of this was originally suggested by Dr. Leidy,‡ and in his latest work he has figured a horn-core from the same deposits which yielded the *Titanotherium* remains.§ The fragmentary specimen described by Dr. Leidy as *Megacerops Coloradensis*‖ probably belongs in the same family, but until additional remains are found this point cannot be decided. The supposed genera *Symborodon* and *Miobasileus*, recently indicated by Prof. Cope (vii, p. 723), belong to this group. The former is generically identical with *Brontotherium*, the reputed absence of lower incisors being evidently due, as shown below, either to age, or to imperfect specimens. *Miobasileus* is apparently the same genus, and hence both names should be regarded as synonyms of *Brontotherium*.

Among the more marked characters of the *Brontotheridæ*, which readily distinguish them from the *Rhinocerotidæ*, apparently their near allies, may be mentioned the following:—There are four short and thick toes in the manus, and three in the pes. The skull supports a pair of large horn-cores, placed transversely, as in modern Artiodactyls.¶ There are well developed canine teeth in both jaws. The molar teeth, above and below, are not of the *Rhinoceros* type, but resemble those of *Chalicotherium*.

---

* AMER. NAT., vol. vii, p. 146, March, 1873.

† Extinct Mammalia, p. 206, 1869.

‡ *Loc. cit.* p. 216.

§ Extinct Vertebrate Fauna, pl. xxviii, fig. 3, 1873.

‖ Proceedings Phil. Acad., 1870, p. 1, and Extinct Vertebrate Fauna, p. 239.

¶ *Rhinoceros pleuroceros* Duv., from the Miocene of France, has a transverse pair of small horn-cores on the nasals, not unlike those in *Dinoceras*. *R. minutus* Cuv. has somewhat similar processes.

The general characters of the *Brontotheridæ* are fully shown in a large series of specimens in the Yale College Museum. The cranial structure of *Brontotherium*, the type genus, is well illustrated in the nearly perfect skull of *B. ingens* Marsh, figured in plates i and ii. The only other genus of the group known with certainty is *Titanotherium* of Leidy (*Menodus* Pomel) which, according to the descriptions of that author, differed essentially in having four lower premolars, and in the absence of a third trochanter on the femur. Less important differences are seen in the composition of the teeth, and in the diastema between the upper canine and first premolar.

The skull in *Brontotherium* is elongated, and resembles in its general features that of *Rhinoceros*. The occipital region is greatly elevated, and deeply concave posteriorly. The brain cavity is unusually contracted. The top of the skull is concave longitudinally, and convex transversely (plates i and ii). The zygomatic arches are massive, and much expanded. The orbit is small, and continuous with the elongated temporal fossa. The nasal bones are greatly developed, and firmly coössified. They support entirely, or nearly so, the large divergent horn-cores. Their anterior extremities are produced, and overhang the large narial orifice. The premaxillaries are diminutive, and do not extend forward beyond the end of the nasals. The palate is deeply arched above, especially between the premolars. The posterior nares extend forward nearly to the front of the last molar. The lachrymal forms the anterior margin of the orbit. The malar extends forward beyond the lower margin of the orbit. The infra-orbital foramen is very large, and situated well forward. The zygomatic process of the squamosal is elevated, and incurved above. There is a massive post-glenoid process, and a large and somewhat shorter paroccipital process (plate i). The post-tympanic process of the squamosal is large, and quite external to the paroccipital process. The occipital condyles are very large, and well separated.

The mandible has a wide condyle, and a slender coronoid process. The angle is rounded, and slightly produced downward. The symphysis is depressed, elongated, very shallow in front, and completely ossified.

The dental formula of *Brontotherium* is as follows:—

Incisors, $\frac{2}{2}$; canines, $\frac{1}{1}$; premolars, $\frac{4}{3}$; molars, $\frac{3}{3}\times 2=38$. The upper incisors are quite small. The canine is short and stout, and placed near the first premolar. The latter is proportionally much larger than the corresponding tooth in *Titanotherium*. The upper premolars have all essentially the same structure, viz: two external connate cusps, with their outer faces nearly plane, and two inner cones closely united. The anterior cone is connected with the opposite outer cusp by a transverse ridge, which has behind it an elongated depression, more or less divided by projections from the outer posterior cusp. In the upper true molars, the external cusps have their outer surfaces deeply concave, while the inner cones are low and separate. The lower incisors were small, and evidently of little use. The two next the symphysis were separated from each other. One specimen in the Yale Museum has the crown hemispherical in form. The lower incisors are frequently wanting, and in old animals the alveoli may, perhaps, disappear. Careful examination, however, will usually show indications of them. The lower canine is of moderate size, and separated from the premolars by a short diastema. The lower molars are of the *Palæotherium* type, and agree essentially with those of *Titanotherium*.

The head in *Brontotherium* was declined when in its natural position. The neck was stout, and of moderate length. The cervical and most of the dorsal vertebræ are distinctly opisthocœlous. The atlas is large, and much expanded transversely. The axis is massive, and has its anterior articular faces much broader than in the *Dinocerata*. The odontoid process was stout, and conical. The transverse process was small, and apparently imperforate. The posterior articular face is concave, and oblique. The epiphyses of the vertebræ are loosely united in most specimens, as in the Proboscidians. The caudal vertebræ preserved indicate a long and slender tail.

The limbs of the *Brontotheridæ* were intermediate in proportion between those of the elephant and the rhinoceros. The humerus is stout, and its entire distal end is occupied by the articulation. The olecranon cavity is shallow, and the condylar ridge similar to that of the elephant, but not continued so far up the shaft. The ulna has its olecranon portion much compressed. Its distal end is much smaller than in *Rhinoceros*, and has no articular face for the lunar. The radius is stout, and its distal end expanded. The carpal bones form interlocking series. They are shorter than in *Rhinoceros*, and support four well developed toes of nearly equal size. The metacarpal bones are shorter than those of the *Rhinoceros*, the first phalanges longer, and the second series shorter. The ungual phalanges are short and tubercular, as in the elephant.

The femur has a small third trochanter, and its head a deep pit for the round ligament. At the distal end, the anterior articular surface is narrow, and the two edges are of nearly equal prominence, as in the tapir. There is a small fossa on the posterior side above the outer condyle. The tibia is stout, and has a distinct spine. The fibula is entire, but quite slender. The astragalus is shorter than in the rhinoceros, and the superior groove more oblique. The cuboid face is larger than in *Rhinoceros*. The navicular has its distal facets subequal. There were three toes of nearly equal size in the pes, the first and fifth being entirely wanting.

The largest known species of this group is *Brontotherium ingens* Marsh, which is represented in the Yale College Museum by a skull, nearly perfect, and other characteristic remains. The specimens preserved indicate that the animals to which they pertained nearly or quite equalled the elephant in bulk, and far exceeded in size any known Perissodactyls living or fossil.

The skull in the type specimen of the species is well represented in the accompanying plates, and its general characters have already been given. It is three feet in length, and twenty-two inches across the zygomatic arches. The most striking peculiarity of this cranium is the pair of huge horn-cores on the nasals. They are about eight inches in length, and extend upward and outward. They are triangular at the base, with the broadest face external. The two inner faces of each core are separated by a ridge, which is continued to the median line. The upper part of the horn-cores is rugose, and the base contains large air cavities. The free extremities of the nasals are coössified, and much elongated. They are rounded in front, slightly decurved, and the surface at the end is rugose. The orbit is of moderate size, and looks forward, outward and upward. The lachrymal foramen is small, and ovate in outline. The infra-orbital foramen is unusually large. There is no post-orbital process. The zygomatic arches are massive, and the squamosal portion widely expanded. The temporal fossa extends far backward, and has over its posterior portion an obtuse ridge. The occipital condyles are very large, wide apart, and extend slightly behind the supra-occipital crest. The paroccipital process of the squamosal is elongate, and its anterior face concave. The post-glenoid process is very large, much extended transversely, and is longer than the paroccipital process.

The premaxillaries in this cranium are imperfect, and the incisors wanting. The canines, also, are not entire, but they were only of moderate size, and in close proximity to the first premolar. This tooth had two fangs, and resembled the other premolars. All of these have a strong inner basal ridge. The crowns are more nearly square than in *Titanotherium Proutii* Leidy. The upper true molars are very large, the last especially so. It resembles the corresponding tooth in *T. Proutii*, but the inner posterior angle of the crown is much more developed.

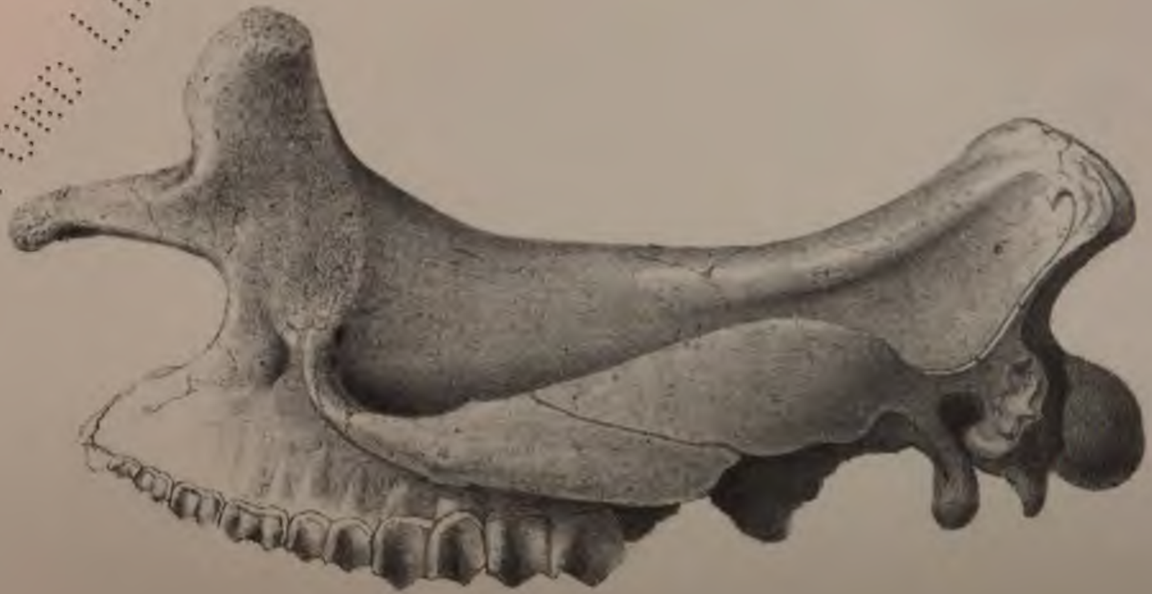
The limbs in this species were shorter than those in the existing elephants, which, in form of body, it doubtless resembled. The huge divergent horns, and the absence of tusks, gave the head a very different appearance. The wide narial opening, the rugose extremities of the nasals, and the very large infra-orbital foramen, naturally suggest that there must have been an elongated, flexible nose, possibly as extensive as in the tapir. That there was no long proboscis, as in the elephant, is indicated with equal certainty by the length of the head and neck, which renders such an organ unnecessary.

This species bears some resemblance to *Brontotherium trigonoceras* (*Symborodon trigonoceras* Cope), but differs widely in size, having been nearly or quite twice as large in bulk. The horn-cores also, are very differently placed; the nasals are more elongated, and not emarginate at their extremities; the premaxillaries are not prominent; the squamosals are greatly expanded; and there is no post-orbital process.

In comparing the *Brontotheridæ* with the equally gigantic *Dinocerata* of the Eocene, several striking points of resemblance will be at once noticed: especially the presence of horns in transverse pairs; the general structure of the limbs and feet; and particularly the short and thick toes. The differences, however, between these two groups are still more marked. In the *Brontotheridæ* there is but a single pair of horn-cores, and no crest around the vertex. The structure and number of the teeth are quite different, while the small canines and huge molars contrast strongly with the elongated canine tusks, and diminutive molars of the *Dinocerata*. The latter, moreover, have two very large dependent

PLATE I.

STANFORD LIBRARY

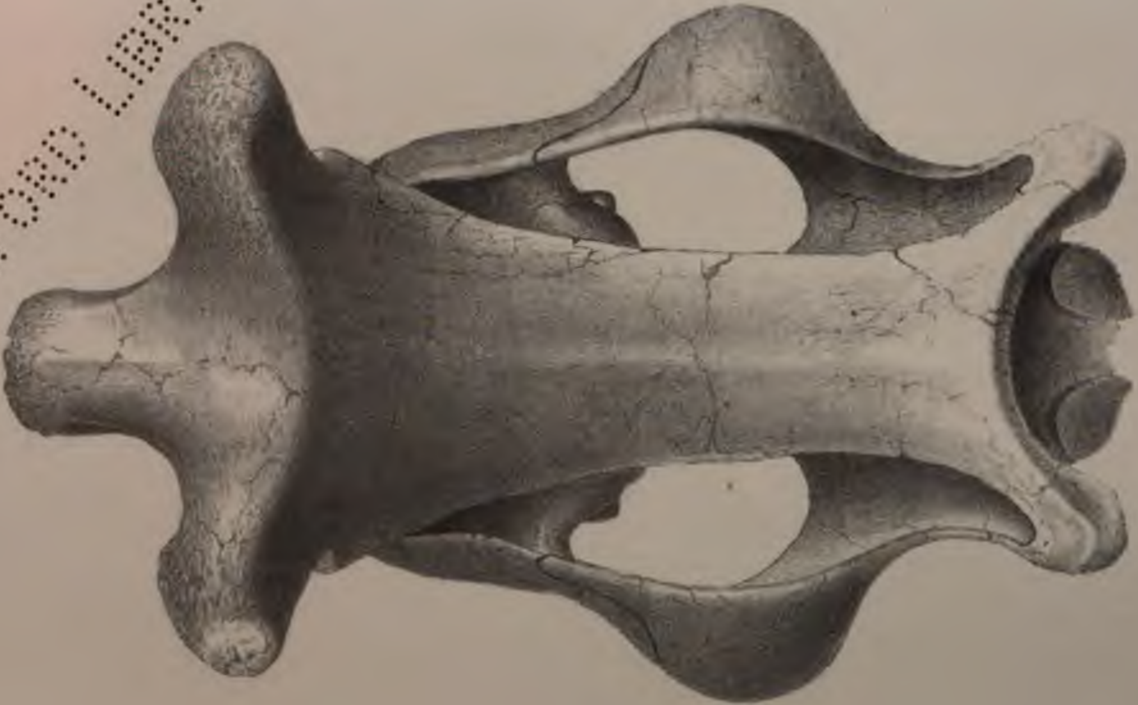


[illegible] [illegible]

BRONTOTHERIUM INGENS, Marsh. ⅛

PLATE II.

STANFORD LIBRARY



[illegible]

processes on each ramus of the mandible; the cervical vertebræ flat; the femur without a third trochanter; and an additional toe in each foot.

Among the features which this group shares with the *Proboscidea* may be mentioned: the superior extension of the condylar ridge of the humerus; the short thick toes; and the late union of the epiphyses with the centra of the vertebræ. The last character appears to belong especially to mammals of very large size, and probably indicates late maturity, and great longevity.

The preceding description makes it evident that the *Brontotheridæ* constitute a very distinct family of the *Perissodactyla.* While retaining some prominent features of their Eocene predecessors, the *Dinocerata*, they are more nearly related to the Rhinoceros family, and at the same time they have some characters allying them to the *Proboscidea*, which replace them in the succeeding, Pliocene period.

All the known remains of the *Brontotheridæ* are from east of the Rocky Mountains, in the Miocene beds of Dakota, Nebraska, Wyoming and Colorado. The specimens here described are mainly from localities in the "Bad Lands" of Colorado, which were discovered and explored by the writer in the summer of 1870.*

EXPLANATION OF PLATES.

Plate i. *Brontotherium ingens* Marsh. **Side view. One-sixth natural size.**
Plate ii. *Brontotherium ingens* Marsh. **Top view. One-sixth natural size.**

ORNITHOLOGICAL NOTES FROM THE SOUTH.

BY C. HART MERRIAM.

II. FLORIDA.

As I was in Florida but a few days and travelling most of the time, few opportunities were afforded for taking satisfactory notes relative to the breeding habits, etc., of many of the birds observed there. The route followed was up the St. John's river to Palatka and thence up its largest tributary, the Ocklawaha river, for a distance of two hundred and seventy-five miles, to a place called "Okahumkee," at the head of navigation.

---

* Amer. Jour. Sci. vol. i, p. 292, Sept., 1870.

For the first hundred and fifty miles the country on each side of the river is thickly wooded, the forests consisting mainly of cypress and palmetto trees: the undergrowth is very dense, and, together with the long and numerous prickly vines, forms an almost impenetrable jungle. To make matters still worse for the collector, nearly the whole country is an immense swamp, and it is very seldom that you see a little knoll rise above the level of the surrounding débris. This is, of course, the home of innumerable birds and a comparative paradise for the ornithologist.

For the remaining hundred and twenty-five miles the river runs through a vast and almost unbroken savanna: here it widens into two good sized lakes, known as lakes Griffen and Harris. A cypress or live oak is occasionally met with on this part of the river; if so, its branches (like those of the other forest trees) are adorned with large quantities of parasitic moss (*Tillandsia usneöides*), which hangs in graceful festoons to the water's edge.

Several miles back from the river (and often not so far) dry land rises out of the water and is covered with pine trees. Alligators are quite numerous about the river, both in the wooded portions and in the savannas.

The following is a list of birds met with during this excursion:

Planesticus migratorius Baird (Common Robin). Not very common. A few seen about the St. John's river. Probably breeds.

Mimus polyglottus Boie (Mocking Bird). Very common about the St. John's river and at Okahumkee. Breeds.

Lophophanes bicolor Bonap. (Tufted Titmouse). Quite common at Green Cove Spring, about the Ocklawaha and at Okahumkee.

Sitta pusilla Latham (Brown-headed Nuthatch). Very common at Green Cove Spring, on the St. John's; also quite numerous at Okahumkee. Gregarious. They seemed to be confined almost exclusively to the pine swamps and barrens, where I have often seen them moving about in flocks of from twenty to fifty. They must breed very early as I obtained the full grown young on the 15th of April. The young of the year differs materially from the adult in having the crown of the same color as the rest of the upper parts instead of brown; the white spot on the nape is also very indistinct. Their note is very peculiar and is entirely different from that of any of the other nuthatches. In habits, they resemble the pine finch (*Chrysomitris pinus*), in climbing about among the long pine leaves and alighting on and picking at the large cones. They also resemble the other nuthatches in creeping over the limbs and trees.

Thryothorus Ludovicianus Bonap. (Great Carolina Wren). Not uncommon at Jacksonville; also seen at Okahumkee. Breeds.

Mniotilta varia Vieill. (Black and White Creeper). Not common about the St. John's and on the Ocklawaha.

Parula Americana Bonap. (Blue Yellow-backed Warbler). Common about the Ocklawaha.

Protonotaria citræa Baird (Prothonotary Warbler). Quite numerous in the large densely wooded swamps of the lower Ocklawaha.

Geothlypis trichas Cab. (Maryland Yellow-throat). Common about the St. John's and the lower Ocklawaha.

Dendrœca cærulescens Baird (Black-throated Blue Warbler). Common on the lower Ocklawaha.

Dendrœca pinus Baird (Pine-creeping Warbler). Common at Green Cove Spring and at Okahumkee. Breeds early; fully-fledged young obtained on the 15th of April.

Dendrœca discolor Baird (Prairie Warbler). Common at Green Cove Spring.

Setophaga ruticilla Sw. (American Red-tart). Common on lower Ocklawaha.

Hirundo horreorum Barton (Barn Swallow). A few seen about the St. John's.

Stelgidopteryx serripennis Baird (Rough-winged Swallow). Not uncommon about the St. John's.

Vireo olivaceus Vieill. (Red-eyed Vireo). Common at Okahumkee.

Collurio Ludovicianus Baird (Loggerhead Shrike). Quite common about the St. John's and at Okahumkee. Breeds. Its note is not unlike that of the Mocking Bird (*Mimus polyglottus*) and it is familiarly known by the natives as the Loggerhead Mocker. It can also imitate many other birds. They are most numerous in the undergrowth (when there is any) in the pine regions, and I never saw one in the swamps.

Pyranga æstiva Vieill. (Vermilion Tanager; Summer Red Bird). Observed only at Okahumkee, where it was not uncommon. It was a shy bird and was generally detected by its pleasant song, and was usually observed in the top of some pine.

Pooecetes gramineus Baird (Grass Finch; Bay-winged Bunting). Not uncommon about the St. John's and at Okahumkee.

Junco hyemalis Sclat. (Black or Common Snowbird). Observed at Green Cove Spring.

Spizella socialis Bonap. (Chipping Sparrow). Common at Green Cove Spring and at Okahumkee.

Melospiza melodia Baird (Song Sparrow). Common on the St. John's.

Cardinalis Virginianus Bonap. (Cardinal Grosbeak). Very common all about the St. John's and Ocklawaha. Breeds.

Pipilo erythrophthalmus, var. **Alleni** Coues (White-eyed Chewink). Very common about the St. John's and Ocklawaha, also Okahumkee. Breeds.

Agelæus phœniceus Vieill. (Red-winged Blackbird). Common in the large marshes on the upper Ocklawaha. Breeds.

Sturnella magna Sw. (Meadow Lark). Common about Okahumkee.

Quiscalus major Vieill. (Boat-tailed Grackle). Very numerous about the large savannas of the upper Ocklawaha. Several were seen on their nests from the boat.

Corvus ossifragus Wilson (Fish Crow). Common on the St. John's and Ocklawaha.

Cyanura cristata Swainson (Blue Jay). Common about the St. John's and at Okahumkee. Breeds. It differs very considerably from our northern blue jay in being much smaller and somewhat darker. The secondaries and tertials, instead of being "broadly tipped with white," are narrowly tipped with it and on some of the secondaries the white is scarcely perceptible: the white band on the tip of the tail is also much narrower and almost disappears on the fourth and fifth feathers. The black bands on the wing- and tail are much narrower and on the tail are much less distinct and do not reach the shafts of the feathers. I will now give the comparative measurements of a Florida specimen and one from northern New York (Lewis Co.).

Locality.	*Date.*	*Age and Sex.*	*Length.*	*Extent.*	*Wing.*	*Tail.*
Leyden, New York.	Dec. 25, 1872.	♂ ad.	12·50	——	5·55	5·80
Okahumkee, Florida.	Apr. 18, 1873.	♂ ad.	10·50	15·50	4·90	4·76

As before stated I obtained four blue jays at Aiken, South Carolina. Three of them were nearly as large as our northern bird, and, in markings, resembled it more than the Florida specimen. The fourth specimen, however, was marked much like the Florida one and its measurements are nearly the same; they are as follows:—length 10·75; extent 15·25; wing 4·90; tail 5·00.

Myiarchus crinitus Cab. (Great Crested Flycatcher). Very abundant at Green Cove Spring and at Okahumkee.

Ceryle alcyon Boie (Belted Kingfisher). Common on the St. John's.

Antrostomus Carolinensis Gould (Chuck-will's-widow). Common on the Ocklawaha and at Okahumkee. Breeds. Strictly a nocturnal species. Roosts on the ground during the daytime.

Chordeiles popetue Baird (Night-hawk). Very common about the St. John's and Ocklawaha. Breeds. Fifty or more often seen at once about the boat in the evening.

Trochilus colubris Linn. (Humming Bird). Very abundant at Okahumkee. Breeds.

Campephilus principalis Gray (Ivory-billed Woodpecker). Rare about the St. John's and Ocklawaha. Breeds.

Picus villosus, var. Auduboni ——. (Hairy Woodpecker). Abundant on the St. John's and Ocklawaha. Breeds.

Picus borealis Vieill. (Red-cockaded Woodpecker). Common at Green Cove Spring and at Okahumkee. Breeds. In habits, resembles *P. villosus.* Has a decided partiality for pine swamps and barrens.

Sphyrapicus varius Baird (Yellow-bellied Woodpecker). Common on the St. John's and Ocklawaha. Breeds.

Hylotomus pileatus Baird (Cock of the Woods). Very numerous about the St. John's and Ocklawaha. Breeds. Confined chiefly to the thick hummocks and swamps. Noisy bird.

Centurus Carolinus Bonap. (Red-bellied Woodpecker). Very common at Okahumkee. Breeds. Inhabits both the pine barrens and the swampy hummocks.

Melanerpes erythrocephalus Sw. (Red-headed Woodpecker). Common at Okahumkee. Breeds.

Colaptes auratus Sw. (Yellow-shafted Flicker; Yaffle). Common on the St. John's and at Okahumkee. Breeds. Differs perceptibly from our northern bird in being smaller and darker. Its dimensions are as follows:—wing 5·75; tail 4·30. The measurements of a specimen from northern New York (Leyden, Lewis Co.) are: —wing 6·50; tail 5·13.

Conurus Carolinensis Kuhl. (Parakeet). Common on the upper St. John's and on the Ocklawaha. Breeds. Gregarious. Roosts in hollow trees. Large flocks of them are often captured by finding a large hollow tree in which they roost and cutting it down after nightfall. They are very noisy birds and if a flock is anywhere in the neighborhood you are sure to hear them.

Strix pratincola Bonap. (Barn Owl). Common about the Ocklawaha. Breeds.

Syrnium nebulosum Gray (Barred Owl) Common on the lower Ocklawaha. Breeds.

Haliaëtus leucocephalus Savigny (Bald Eagle). One seen sailing over the St. John's. Breeds.

Pandion Carolinensis Bonap. (Osprey; Fish Hawk). Common about the St. John's and Ocklawaha. Breeds.

Hypotriorchis columbarius Gray (Pigeon Hawk). Not uncommon about the St. John's.

Tinnunculus sparverius Vieill. (Sparrow Hawk). Common on the St. John's and Ocklawaha. Breeds.

Buteo (borealis?) Vieill. (Red-tailed Hawk). Several *Buteos* were seen about the Ocklawaha, probably *B. borealis.*

Nauclerus forficatus Ridgway (Swallow-tailed Kite). Common about the St. John's and Ocklawaha. Breeds. The power of wing exhibited by this magnificent bird is truly wonderful. Its rapid flight and abrupt turnings can only be compared to those of the swallow. I have often seen them dart down and pick a wasp's nest from a leaf on the top of some high palmetto and fly off with it, devouring the grubs it contained while on the wing.

Cathartes aura Illig. (Turkey Buzzard). Common on St. John's & Ocklawaha. Breeds.

Cathartes atratus Lesson (Black Vulture). Very common on the St. John's and Ocklawaha. Breeds. Much more plentiful in Florida than *C. aura.* I have seen at once on a dead tree twenty-four of these birds and two turkey buzzards.

Zenædura Carolinensis Bonap. (Common Turtle Dove). Common about the St. John's and Ocklawaha. Breeds.

Chamæpeleia passerina Sw. (Ground Dove). This miniature Dove was quite common about the St. John's. Breeds.

Meleagris gallopavo Linn. (Wild Turkey). Common in the thick hummocks on the upper St. John's and Ocklawaha. Breeds.

Ortyx Virginianus, var. **Floridanus** Coues (Florida Quail). Common about the St. John's and at Okahumkee. Breeds.

Grus Canadensis Temm. (Sand-hill Crane). Common on the Ocklawaha.

Aramus giganteus Baird (Crying Bird; Limpkin). Common on the Ocklawaha. Breeds. Limpkins are very noisy birds; they would sit on a limb over the water and scold at us as the boat passed by. They were breeding and I noticed several females sitting on their nests as we passed; they were placed in the fork of some tree, or at the junction of some limb with the trunk, generally about eight feet above the ground (or water), and were constructed rudely of sticks, measuring externally about eighteen inches in diameter by ten deep.

Demiegretta Ludoviciana Baird (Louisiana Egret). Not uncommon on the Ocklawaha. Breeds.

Garzetta candidissima Bonap. (Snowy Egret). Common on the upper Ocklawaha. These beautiful birds were often seen in flocks of from ten to fifty, together with the white herons (*Herodias egretta*) and water turkeys (*Plotus anhinga*). They all breed together in the bushes that cover some parts of the large savannas, and construct rude nests of sticks.

Herodias egretta Gray (White Heron). Common on the upper Ocklawaha. Breeds.

Ardea herodias Linn. (Great Blue Heron). Common on St. John's and Ocklawaha. Breeds.

Florida cærulea Baird (Blue Heron). Common on the upper Ocklawaha. I obtained one nest of this bird at Okahumkee; it was built carelessly of sticks and was placed on some bushes about five feet above the ground. It was on a little floating island in a small pond, and contained two fresh eggs. The old birds were very shy and did not come within shooting distance.

Ardetta exilis Gray (Least Bittern). Common on the upper Ocklawaha. Breeds.

Botaurus lentiginosus Steph. (Bittern; Stake Driver). Common on upper Ocklawaha. Breeds. The natives call this bird "Scroggins."

Butorides virescens Bonap. (Green Heron). Common on upper Ocklawaha. Breeds.

Nyctiardea gardeni Baird (Night Heron). Common on upper Ocklawaha. Breeds.

Gallinula Martinica Lath. (Purple Gallinule). Common on the upper Ocklawaha. Breeds. These beautiful birds were very tame and would run about on the lily pads without showing any signs of fear as we approached and passed them. Natives call these birds "Blue Peters."

Fulica Americana Gmelin (Coot). Common on upper Ocklawaha. Breeds.

Plotus anhinga Linn. (Water Turkey; Snake Bird). Common on Ocklawaha. These curious birds, though unexcelled swimmers and divers, are generally observed perched on the top of some tall tree where their long necks can be seen for some distance. As the boat approached they would fly ahead and again alight in a similar situation. We sometimes saw them swimming in the water ahead of us and as the boat neared they would sink: they must be able to remain under water for a long time, for after diving I never saw one rise again. I obtained one of their nests at Okahumkee. It was built on the same floating island as that of the blue heron (*Florida cærulea*) before described. It was composed of sticks rudely laid together on the top of a bush, about eight feet high and contained four fresh eggs. I shot the female bird on the nest.

THE BOTANY OF THE CUYAMACA MOUNTAINS.

BY J. G. COOPER, M.D.

During the last week of April, 1872, I made a rapid but very delightful trip through a region scarcely known to naturalists, and of which the very name, as given above, is not, I believe, to be found on any published map.

Yet it is a range equal in extent and height to the White Mountains of New England, that favorite resort of eastern naturalists, which has furnished them with so many interesting subarctic species both of animals and plants.

The highest ridge of the Cuyamaca range lies forty miles east of San Diego Bay, being at the southwest corner of the Union, and thus almost the antipodes of the White Mountains: with which, however, we may compare it in many respects.* The summits of the three highest peaks are thus nearly as far from the coast as Mount Washington, and the central one, measured by my companion, Mr. W. A. Goodyear of the California Geological Survey, was found to be also about six thousand two hundred feet above the sea by mercurial barometer. The great mass of the range is granite, with some mica and talcose slate on its flanks, especially the eastern, where there are also gold mines, not long opened, but already paying well.

The foot-hills of the range commence about ten miles from the coast, some of them at once rising into rugged hills over one thousand feet high, and very conspicuous from contrast with the nearly level table-land (or "Mésa" of the Spanish-Americans), which extends from the sea inland, and often among the bases of the hills up to eight hundred feet elevation. This mésa is of very recent geological age, and has been lifted by successive stages so that it presents the appearance of more or less continuous terraces, at various intervals inland.

On the east side the descent is exceedingly rapid. from an elevation of four hundred feet a few miles east of the highest peaks, down to the Colorado Desert, which has lately been found by the railroad surveyors to be actually over two hundred feet below the level of the sea in its central parts. Looking off from the mountains in that direction, we see an immense, sandy level plain, bounded by distant rugged mountains toward the northeast, but illimitable toward the southeast, except by the dim misty horizon. Not a tree nor a trace of green vegetation relieves the eye, and we gladly turn away from it to the verdant hills above the summit of the wall from which we have been looking eastward.

---

* The present article will show that on account of the scarcity of that one essential element, water, the southwestern range produces much fewer species than the northeastern.

The base of the range is therefore about fifty-five miles wide, with a slope of five thousand four hundred feet in thirty miles toward the west, and of the same amount in only fifteen miles on the east. It is singular that all the water falling *east* of the high peaks finds its way around them and runs to the *west*.

VEGETATION. — Being thus the western rim of the desert, the dryest portion of the United States, where the rainfall (as measured at Fort Yuma) averages only about *two inches* annually, we may expect the mountains to partake, in some degree, of the sterility of the desert itself. But their vicinity to the Pacific Ocean, that exhaustless reservoir from which most of the rains of the western slope are derived, produces a fair amount of rainfall in winter, and at the same time increases the dryness of the desert, by intercepting this precipitation. At the same time the *summer* rains of Mexico and Arizona are to some extent poured out upon the eastern slope of the mountains between four thousand and six thousand feet elevation, thus failing to reach the coast, though they can be seen frequently from San Diego falling as thunder-storms upon the mountain tops, and very rarely pass over the lower passes northward to the Los Angeles plains.

Consequently the highest ridge is thickly clothed with trees, and although they end at four thousand feet on the east slope, they extend down the western, gradually thinning out, to the edges of the mésa, and thence along the banks of the rivers nearly to the sea. The lower mountains, and parts of the mésa are covered with shrubs but scarcely dense enough to hide the sterile rocks and gravel.

Near the sea, herbage of various kinds, but thin and of little value as pasture, covers the surface; improving, however, where ploughing has loosened the soil, packed almost to the hardness of bricks by two centuries of cattle-grazing and by the arid climate. A narrow belt of shrubby oaks (Adenostema and

Spiræa with some other shrubs), runs along within a mile of the beach, watered and sustained by the sea-fogs. Then comes what may be called the cactus zone, as six or eight species of that family, with low yuccas and other plants of the group bordering the desert are the most striking growth, often forming thickets by themselves in sandy places, and being in the dry season almost the only green vegetation. The laurel sumach (*Lithræa laurina* Nutt.) is a shrubby tree accompanying them in thickets of small extent.

These characterize the mésa, scarcely ascending above it, and form indeed the northern extension of the flora of the still more arid peninsula. The river-bottoms are more fertile, many grasses, flowering plants and small live-oaks (*Quercus agrifolia* Nees), sycamores and willows, lining the edges of the water-courses, which are, however, usually dry during nine months of the year, for a distance of five or six miles above their mouths. This valley vegetation consists chiefly of plants more common on the moist mountains, and in a great degree of species belonging to the northern instead of the southern (or lower) Californian flora. Some of the sandy portions, however, reproduce nearly the same group as the Colorado valley. Of course it is quite possible that isolated specimens of some trees may exist, not met with on our journey.

As the botanists of the Mexican Boundary, and Pacific R. R. Surveys have explored and thoroughly analyzed the flora of these lower zones, I will refer to their reports for further details.

The forests of the mountains may perhaps be best illustrated by giving an abstract of my observations made during our brief journey across them, at the same time giving an idea of the climate at the end of April.*

April 26th. At 1 P. M., we left town and rode over the mésa to the San Diego river, encamping a mile above the old Mission, where date palms and olives in cultivation give quite a tropical aspect to the already parched and barren scene. A few pools of stagnant water only remain in the wide sandy river-bed. I walked from camp three miles over the mésa north of the valley, to where it abuts against the granite hill through which the river has cut a deep narrow cañon, returning for two miles through the lower part of this cañon. A little rivulet still runs down here, but sinks before reaching camp, and we had to obtain water from a well. Oak and sycamore (*Platanus racemosa* Nutt.) are here quite luxuriant close to the water but disappear below camp, and even willows become very small.* Remains of the ancient aqueduct, built by the Spanish missionaries full seventy years ago, to carry water from above this cañon nine miles to the mission, are very conspicuous, and show much engineering skill, as well as excellent workmanship.

---

* In the tables of tree distribution in the Smithsonian Report, for 1858, I gave "San Diego Mountains" as the southwest range of many species not found there by me, having been wrongly informed as to their locality.

April 27th. Mr. Goodyear and Mr. Fox of the Southern Pacific R. R., walked up the cañon to examine the geology and the aqueduct, finding an excellent dam, which has withstood nearly a century of summer droughts and winter torrents. I rode up the south mésa nine miles to Cajon valley, a basin lying between the mésa and the hills, in part the remnant of an old lake-bed excavated by the river before it broke through the hills. It now however looks very arid, the granitic gravel covering it being only thinly concealed by crops of wheat just ripening, and the surrounding native vegetation being all dried up. A few small elder trees (*Sambucus glauca*) are the only green things visible about a spring on the south side of the valley.

The river runs on the north side, six miles distant, and is there pretty well lined with the trees mentioned, together with some large cotton-wood poplars (*P. monilifera*). Its elevation being four hundred feet above the sea, and the impervious granite retaining the moisture, we find a great increase in tree growth compared with the lower region, but still confined to the moist river banks. The greater moisture is still further shown by the fact that although so arid, this is the first valley where a crop is successful this year, though it will mostly be cut for hay, which is so high priced at San Diego as to make it more profitable to cut it than to wait for the uncertain and light crop of wheat. Some other grain and vegetables are also raised along the river. The California wild grape (*Vitis Californica* Benth.) grows in moist spots about this valley. The green cornel (*Cornus pubescens* Nutt.) also forms a small tree along the streams.

About six miles east, the river again forms a cañon in which it never dries up and where the Indians have their favorite settlement, convenient to the acorn crop. The road, however, leaves this cañon on the north, ascending over rolling granitic hills, on which, at about six hundred feet altitude, we meet the first thick-cup oak (*Quercus crassipocula*), a curious form, with pale oval leaves, sometimes lobate, which remain green all winter down here, and fall on the coming out of the new leaves, now just grown. Various mountain plants, before unseen, accompany it, and it is perhaps the limit of the orange, which has been growing here for more than ten years successfully on Ames' ranche. The most notable shrubby trees are the northern evergreen plum (*Prunus ilicifolia* Nutt.), "wild lilac" (*Ceanothus thyrsiflorus* Esch.), and a shrubby live oak (*Q. Ransomi* Kell.).

---

* Two or three species in these mountains grow sixty feet high and two in diameter, but I cannot name them.

Five miles from the valley at Flynn's, about nine hundred feet elevation, and in a narrow ravine, we first found a really luxuriant vegetation; the trees very large, crops heavy and a fine orchard, eight years old, of all the common fruits and some young orange-trees, figs, grapes, etc. The chief cause of this productiveness was forcibly impressed on our mind, by finding that the usual sea-fogs, which had been more dense than usual this day in the form of a cloudy sky, began to condense into rain after sunset, and heavy showers continued during the whole night. We afterwards learned that this rain was light in Cajon valley, but did not reach San Diego at all, though general in the northern part of the state.

April 28th. Light showers continued until 10 A. M., and as the clouds lifted, we saw the Cuyamaca Mountains, white with snow, only a few miles east of us. Crossing rocky and mostly barren granitic hills, which become more and more covered on their north slopes with large shrubs of northern species of Ceanothus, Arctostaphylus, etc., we reached another old lake bed called "Valle de los Viejos" (from some ancient aborigines found there by the first Mexican visitors), having an elevation of over two thousand feet, and where the verdure of spring was scarcely beginning to wither, but showed a paucity of species indicating that it is too cool for the southern desert forms and too dry at times for many of the northern.

From this we ascended a steep rocky ridge one thousand five hundred feet more, from the top of which we could look down on San Diego Bay, and distinguish the lighthouse plainly, to the southwest. Shrubs only cover this slope, but on crossing the summit, we immediately enter a scattered but luxuriant forest of live oak (*Q. agrifolia*). The scene reminded me strongly of the similar growth on the mountains near Santa Cruz two hundred and eighty miles farther north, near the sea-level. Crossing a wide valley with a fine running stream, we ascended again and encamped at a height of three thousand eight hundred feet, about two hundred feet below the commencement of the pine growth. The two evergreen oaks here grow splendidly, scattered among grassy meadows fit only for grazing, on account of early frosts.

April 29th. There was heavy frost in the night forming thin ice at camp. Still gradually ascending through a lovely forest, alive with the songs of migrating spring birds, we found the yellow pine (*P. ponderosa* Dougl.) at a height of about four thousand feet, and a little higher the black oak (*Quercus Sonomensis*) just leafing out, a most beautiful reminder of the northern deciduous forests. Then comes the lofty and magnificent sugar pine (*P. Lambertiana* Dougl.), and near the summit of the dividing ridge, the graceful "white cedar" (*Libocedrus decurrens* Torr.), and a spruce which seemed, from the remnants of cones, to be the noble fir (*Picea nobilis* Dougl.), at about five thousand feet elevation, forming a tree three feet in diameter.

We have thus above the cactus zone, a zone of oaks from six hundred to four thousand feet, and then a zone of pines from four thousand. to six thousand two hundred feet, but the former encroaches widely on the latter.

The road crosses this summit by an easy grade, close to the base of the highest peak, and a dense forest covers this and the other two next highest, which lie north and south of it. Circumstances prevented me from ascending the summit, very much to my regret, but I was informed by the gentlemen who did so, that the sugar pine and fir form the chief growth, with some oaks and Libocedrus and a less common pine with lower growth and spreading branches, but very large cones, apparently the *P. Sabiniana* Douglas, of the lower Sierra.

Frozen snow covered the branches of these trees for five hundred feet below the summit, making it dangerous for the travellers, from the chance of heavily encrusted branches or cones falling on them, but they made the trip safely, there being no wind, and the sun coming out so warmly, as soon to clear away the icy coating. The alder (*Alnus oblongifolius* Torr.) and sycamore continue up to five thousand feet on the west side of this ridge, but disappear on the eastern. Descending about five hundred feet to the Stonewall mine, the country is varied with grassy meadows and hills covered with yellow pine and thick-cup oak, which here nearly altogether replaces the *Q. agrifolia.* It is also less forward in leafing than on the west slope where first seen, the old leaves almost all remaining. A low ridge east of this, and forming the summit of the steep descent to the desert, produces a scattered growth of the *P. Sabiniana* almost alone, just as it grows on the foot-hills bordering both sides of the San Joaquin valley, etc.

Among the herbaceous plants I recognized most as familiar northern species, and saw indications in their forms of a more arid climate than on the west slope at the same elevation. Our rapid journey and want of materials prevented me from obtaining a series of them, which would be interesting if only for the purposes of geographical botany.

April 30th. The road now going northward led us over the east base of the most northern peak, where I was much surprised at passing through one of the densest forests I have seen in California, for a distance of about five miles, consisting of the two live oaks and sugar pine, the former sometimes five to seven feet in diameter. The variety of *Q. agrifolia*, called *Q. oxyadera* by Torrey, is quite numerous from two thousand to four thousand feet altitude. What made it most surprising was that a few rods from its sharply defined eastern edge, is the rocky barren ridge forming the rim of the desert, and it seemed unaccountable how such a dense growth of trees could exist there. I was informed, however, by Mr. Fox that the "Sonora rains," as they are called here, are very frequent on this slope during summer, supplying the requisite moisture. He also told us that Pine valley, about fifteen miles southward, is the limit of pines in that direction, the mountains becoming so low near these as to intercept little moisture and to be consequently very arid. Such is their character along the line selected for the Southern Pacific R. R., and as far as can be seen in lower California.

The thick woods do not descend below about four thousand five hundred feet, where we came to a rolling hilly country, grassy and with scattered trees, chiefly on north slopes, of the oaks, yellow pine and *P. Sabiniana*, — extending to San Felipe Pass, at the summit of which are the most productive gold mines, and the rising village known as Julian City, four thousand feet elevation. The situation is beautiful at this season, but the whole of this slope is too subject to the parching east or "Desert" winds to be of much value for any but mining purposes. From here the descent toward the northwest is very rapid, and pines end all at once; oaks, however, continuing on the north slopes and in moist spots. The *Quercus agrifolia* becomes again more common than the *Quercus crassipocula* which ceases at about six hundred feet. On the east slope it will be noticed that the zone of oaks is entirely wanting, or is mingled with that of pines, while the cactus zone immediately succeeds them.

Here the Cuyamaca range ends, being separated from other ranges to the north and northeast by the Pass and by Santa Isabel valley at the head of San Bernardo river. Its length, from this to the railroad pass near the Mexican Boundary, is thus about twenty-five miles, its width about the same, leaving out the low foot-hills on the west, and including only the portion above an elevation of two thousand feet. Descending into the valley, the sycamore reappears at about three thousand eight hundred feet, the cottonwood at three thousand five hundred feet, and the black oak disappears at the same elevation. The country is more cut up by wide valleys than on the slope we ascended, but they are generally drier at the same altitude. At our camp in a narrow valley, one thousand eight hundred and fifty feet high, trees were scarce, and crops grew only by irrigation.

May 1st. The road led over a rolling granitic ridge of hills between the San Bernardo and San Diego rivers, with scanty herbage and scattered oak groves, to the north side of Cajon valley, where we looked down from about one thousand feet elevation over this curious basin six hundred feet below us, and also over the terraced mésa toward the ocean, plainly perceiving San Clemente island eighty-five miles distant. The "Desert wind," which commenced yesterday, made the air unusually clear, but at the same time was so hot and dry as to be very uncomfortable. The Cuyamaca peaks appeared now to be completely bare of snow.

As the rest of the journey back was over the same route before described, I omit farther extracts from my journal. It must appear from these notes that this range, from its liability to severe droughts, does not have such a luxuriant flora and sylva as might be expected from its southern position, the trees being all merely stragglers from more northern forests, and none of them, except the yellow pine and oaks, found in great abundance. At the same time the altitude of the central peaks, and the consequent coldness around their bases (snow falling on them as late as the middle of May some years), prevent the growth of the more southern group of trees and plants, which might find the moisture sufficient, above one thousand feet.

This is shown by the fact that in two isolated localities not far from this range, but in the low country, are small groves of trees probably belonging properly to the Sylva of the warmer high mountains of lower California. One of these is *Pinus Torreyana*, growing scantily on the sandstone bluffs near the mouth of Soledad creek, nine miles north of S. Diego Bay, and three hundred and fifty feet above the sea. The other is *Quercus oblongifolia*, found near the head of San Luis Rey river, sixteen miles north of Santa Isabel valley, and about one hundred and fifty feet altitude.* Besides these we miss on this range many northern trees found on the San Bernardino Range (eleven thousand six hundred feet high, by Mr. Goodyear's measurement). Of these I have noted the far-spread red fir (*Tsuga Douglasii*) and walnut (*Juglans rupestris* Englm.). The nut pine (*P. monophyllus* Torr.), and juniper (*J. occidentalis* Nutt.), of the great arid basin east of the mountains, very probably grow scantily lower down the eastern slope of this range.

SCIENCE IN THE UNITED STATES.

FROM THE FRENCH OF ALPHONSE DE CANDOLLE.

[The following extract is taken from a recent publication, entitled "Histoire des Sciences et des Savants depuis deux siècles" — a very curious and instructive work, in which the lists of foreign associates and correspondents of the three leading scientific academies (those of Paris, London and Berlin) have been scrutinized with elaborate care and subjected to a most searching analysis. The passage which we have translated is a section upon the United States, contained in a detailed "examination of different countries viewed with regard to the causes of their influence on the sciences." It is difficult fully to appreciate the argument which runs through this extract, without presenting such an analysis of the whole work as would occupy too much space. We commend the entire volume to the careful study of the readers of the NATURALIST, as an admirable example of a scientific essay. — S. H. SCUDDER.]

---

* I am inclined to believe this to be only a very luxuriant growth of *Q. crassipocula*, but have not seen the acorns.

The two foreign associates of the French Academy, and the majority of the American correspondents of this Academy and of the two other bodies above mentioned,* belong to the New England states. Consequently, calculations based on the Union taken as a whole do not give correct ideas, and, to appreciate the influences at work, we must distinguish between the six northeastern states and the rest of the country.

The most brilliant epoch for New England was that of Franklin and Rumford. The population of this part of the United States was at that time only half a million, and in consequence of its origin it presented very favorable conditions.

The only unfavorable conditions were our Nos. 1, 2, 7 and 18.† None of these are very important or very characteristic. We thus understand why New England has made the same progress in science as the most civilized countries of Europe. The early pilgrims resembled the protestants expelled from France and Belgium, in their ancient intellectual culture, their devotion to ideas rather than to interests, their laborious and austere life.

The rigor of the old Calvinism gave place at Boston, as at Geneva and in Scotland, to broader and more tolerant ideas. Without this a Franklin would not have been possible, and the scientific influence of Harvard University can scarcely be otherwise explained. If, to-day, anything would seem to threaten this select population of New England, it is the incessant emigration of its youth to other parts of America and the immigration of foreigners for the most part very different from the early settlers. Perhaps also the characteristic activity of Americans is an obstacle to the cultivation of the sciences, even in the New England states. Taking the Union as a whole, the principal difficulty evidently lies here. The young men abandon their studies early in life. They change their residence and profession again and again, hoping for greater and more speedy gains. *Savants* whose learning does not extend to trade stand strangely alone in a society thus devoted to the production of all mercantile commodities. The inventive genius of Americans also gives the preference to applications which do not strictly belong to science. I need only repeat here what a very distinguished American *savant* said recently at the opening of a session of the scientific association of the United States.* Moreover, to be just, and to reply to certain European notions founded on a superficial knowledge of the people of the United States, it will be well to add one remark. It is not through greed of gain and of material pleasure that the Americans throw themselves with such ardor into lucrative pursuits. They are quite capable of sacrificing their interests to ideas, as we have seen in their great civil war. It was surely for the interest of both parties that they should then, by means of mutual concessions, continue to live in peace; but the south held to the original sovereignty of each state, the north to the present and future aggrandizement of the United States, and a portion of the people aimed at the abolition of slavery. They sacrificed everything to sentiments and ideas. When a few hundred men can be found among the Americans, as zealous for the advancement of science as their volunteers were for political opinions, they will make marvellous progress. It is not activity nor intelligence which they lack: it is the will to apply themselves to that which brings in no return, and which is not in sympathy with the popular taste.

---

* The Royal Society of London and the Academy of Sciences of Berlin.

† These are given on a previous page, as follows:

1. Small proportion of persons belonging to the rich classes, as compared with those who are obliged to work for their living and especially to labor with their hands.

2. Small proportion among the richer classes of those who are contented with their income and whose property requires but little attention, so that they are inclined to devote themselves to intellectual pursuits by no means lucrative.

7. Insufficient and poorly organized material for various scientific work, such as libraries, observatories, laboratories and museums.

18. Distance from civilized countries.

---

* "True, it has already given to the world many a master work, in the arts of peace and the arts of war; the steamboat, the cotton gin and the sewing machine; the practical application of the electric telegraph, and the means of its printed record; the most perfect form yet attained for the steam engine and the steam boiler; the most powerful ordnance and the most impregnable vessels; the telescopes of Clark and Fitz, the microscopes of Spencer and Tolles, and the means of annihilating pain. . . . . But what I would now say is, that, whatever may be the claims of our country to have done her part in the furtherance of civilization so far as depends upon the solution of high political problems and upon advancement in the arts, her contributions to science have not kept pace with these; nor, indeed, with those of several European nations which have had to contend against obstacles quite comparable in magnitude with our own, even though of a totally different nature." Address of ex-president B. A. Gould in 1869. [This extract is from the original. DeCandolle quotes from an incomplete translation which appeared in the Gazette Médicale de Paris, May 20, 1871. The address was delivered in 1869, not in 1870, as stated by DeCandolle.]

It would seem also that in this young nation (excepting New England) the people are of a very speculative turn of mind. Poets of both sexes are numerous. Religious sects sometimes give evidence of a great power of imagination. The most eccentric, that of the Mormons, strove to reëstablish a well known institution, polygamy, but it has also invented the theory of spiritual wives, which, by its purity, its grace and its novelty, really deserves a prize of poesy. Spiritualism has found more favor in the United States than in Europe. Now to reach a brilliant scientific epoch, we must have a public eager for abstract truth, for things which may be demonstrated by perfectly sure processes; and, I should add, things of little or no practical use.

Precedents, traditions, so advantageous to free scientific labor, are wholly wanting among most of those who emigrate to the United States. The selection of this population is brought about by a desire for lucrative employment, and the result is in perfect accordance with the theory. It would be quite different, if, for example, wars and revolutions were gradually undermining civilization in Europe, and if thousands of families who had followed liberal professions for one or two centuries, hoped to find more security in America. We should then see, on a large scale, what took place for the benefit of New England, of Switzerland, of Holland and of Prussia, at the time of the old persecutions of French and Belgian protestants. America would have inherited the secular culture of sciences in Europe. In the absence of similar circumstances, the extension of inherited fortunes, of instruction, and of the isolation, already apparent, of many enlightened men in the midst of democratic tumult, must gradually develop, among a certain class of the American people, a taste for disinterested and purely scientific research.

Distance from the old civilized countries has long been injurious to the labors and the reputation of American *savants*. In proof of this, we may notice that the only citizens of the United States called to the high distinction of the title of Associate of the French Academy of Science, Franklin and Thompson, Count Rumford, had resided in Europe, the first in a conspicuous position, the other for a long period of years.* Otherwise, it is very possible that less attention would have been paid to their labors. In our day, communication has become more ready. Many young Americans study in Europe. Others come to travel after publishing memoirs. Their scientific zeal is thus increased, and the European *savants* become better acquainted with them. Finally, the Anglo-American language is destined, by the force of circumstances, to predominate. In every way, therefore, one may expect a larger development of the sciences in the United States — it is true in a somewhat distant future, for favorable influences make themselves felt only after one or two generations.

---

* DeCandolle's tables end with 1870. Since then the late Professor Agassiz was elected a Foreign Associate, though DeCandolle would have probably classed him with Swiss scientists, as not having been born and educated in America.—EDS.

BOTANICAL OBSERVATIONS IN WESTERN WYOMING.

BY DR. C. C. PARRY.

No. 2.

Wind River, which in pursuing a general southeast course drains the entire eastern slope of the Wind River range, also receives from the east and north the drainage of an extensive mountain district, to which, as a whole, no distinctive name has yet been applied. To the most southeastern extension of this mountain system the name of Owl Creek range has been locally applied. At the lowest point, where this merges into the open and elevated plains, the main stream, turning sharply to the north, loses the name of Wind River to assume that of the Big Horn, tributary to the Lower Yellowstone. Thus it happens that the same stream, under another name, in doubling on its upper course from southeast to north, receives lower down the eastern drainage of the Owl Creek range, and the broken mountain district to the northwest, through the little known Big Horn tributaries of Owl Creek, Gray Bull and Stinking Water.

Our route, instead of following down the main valley, crossed Wind River some distance above the sharp bend above referred to, thence crossing a low spur of the Owl Creek range, and skirting near the base of the high mountains to the west, passed Owl Creek, Gray Bull and several southern tributaries of Stinking Water, to ascend a main branch of the latter stream to its source in the high divide separating its waters from those of the Yellowstone basin. On this route the chief point of botanical interest centred in the comparatively little explored district of Owl Creek range, the valleys of Owl Creek, Gray Bull and Stinking Water, and the high mountain region at the sources of the last named stream. We accordingly note briefly in their order of passing the features of botanical interest presented on our route.

The valley of Wind River, as its name suggestively implies, is especially subject to the sweep of fierce northwest winds, which necessarily leave their impress upon the native vegetation. Thus everywhere on the uplands and low open valleys there is a close uniform growth of stunted grasses, or the dull moorish aspect presented by the constantly recurring Artemisia. On saline flats the view is hardly improved by a ranker and more verdant growth of the spine-clad *Sarcobatus;* everywhere there is a monotonous recurrence of the same forms of vegetation, comprising such only as are capable of withstanding the combined unfavorable influences of a parched soil during the season of summer growth, followed by an early and rigorous winter. Only in moist, sheltered bottom-lands do we meet with anything like a rank vegetation, made up of dense willow thickets, occasional copses of *Shepherdia argentea* Nutt., with irregular scattering groves of *Populus balsamea.* Especially abundant in all damp, rich, alluvial tracts in this region we meet with the "wild licorice" (*Glycyrrhiza lepidota* Nutt.), here very commonly infested with a parasitic fungus, *Trichobasis leguminosarum* Link.

In the series of steep bluffs bounding the main river bottoms, the deep gullied ravines offer a greater variety of soil and exposure favorable to a diversified and peculiar vegetation. Here, accordingly, among other rarities we meet with a well marked new species of Astragalus, distinguished by its loose straggling habit, growing in light loamy soil, and sending up a loose spike of white flowers which rarely mature fruit. Prof. Gray has characterized this species (No. 65 of the distributed collection) as *A. ventorum*, n. sp. (see appendix). Here also along the slopes of high gypseous ridges we meet quite abundantly with a new composite, *Schkuhria* (*Platyschkuhria*) *integrifolia* Gray, n. sp. (see appendix, No. 150); of a habit and foliage quite unlike any other species of this genus.

On reaching the broken foot-hills of the Owl Creek range, both the scenery and vegetation became much more diversified; and rounded slopes of disintegrated metamorphic rocks, sharp crests of upheaved strata, and extensive exposures of the brick-red Triassic formation, present in their varied exposures all the conditions for a varied flora. We accordingly here meet with such choice plants as *Stanleya viridiflora* Nutt., *Oxytropis campestris* L., var.? (No. 88), *Aplopappus multicaulis* Nutt., *Tanacetum capitatum* Nutt.

Farther up on the mountain slopes the increased elevation is evidenced by greater freshness of vegetation, the dull brown of the lowlands giving place to a rich soft verdure. Constant running streams, however, are still rare, as the altitude is not sufficient to afford heavy deposits of winter snow to keep up a supply of water through the dry summer months. As we again encounter pine woods composed mainly of *Abies Douglasii* and *Pinus flexilis*, the associated undergrowth is again brought to view in thick, matted growths of *Arctostaphylos uva-ursi*, and occasional patches of *Berberis Aquifolium*. Still there is a characteristic absence of many forms such as one would naturally look for in such localities, neither scrub oak, Rubus nor Symphoricarpus being here represented. Very common and attractive over all this district are the bright, showy flowers of a species of Lupinus (No. 54) allied to *L. sericeus* Ph.? but difficult to refer to any described species; here also *Hedysarum boreale* Nutt. is conspicuous, with its slender spikes of nodding pink flowers, occasionally inclining to a dull pinkish-white. On the crests of the dividing ridge attaining an elevation of nine thousand feet there are extensive exposures of an arenaceous limestone, presenting tabled summits and perpendicular mural faces, with irregular broken talus at their bases. These localities offer not only very attractive points of view of the adjoining country, but afford a rare field for the botanist. Here in rock crevices was found the charming dwarf columbine, which, in compliment to the enterprising commander of the expedition, and its first actual discoverer, I have named *Aquilegia Jonesii*, n. sp. (see appendix, No. 3). This species, which is most nearly allied to *A. vulgaris* L., is sufficiently distinguished by its dwarf size and close cæspitose habit, as well as other well marked characters indicated in the description referred to. It would no doubt prove highly ornamental in cultivation, but unfortunately at the period of our collection (in July) the fruit was just maturing, and it was only by diligent search that sufficient late flowering specimens were met with to complete the description.

Besides this choice addition to our native flora, other plants worthy of note may be enumerated, viz: *Anemone multifida* DC., *Arenaria arctica* Stev., *Arenaria Rossii* R. Br., *Lupinus minimus* Dougl., *Oxytropis campestris* L., *Spiræa cæspitosa* Nutt., *Saxifraga Jamesii* Torr., *Saxifraga debilis* Engel., *Phlox Douglasii* Hook., *Polemonium confertum* Gray, *Androsace chamæjasme* L., *Castilleia pallida* Kth., *Lloydia serotina* Reich.

The peculiarities of the timber growth in this section will be more fully dwelt on in a subsequent article; it is sufficient here to note the regular order of succession everywhere noticeable as distinct zones of arborescent growth. Thus the lower mountain slopes are occupied by scattered groves of *Pinus ponderosa* and *Abies Douglasii*, succeeded higher up by *Pinus flexilis* and *Pinus contorta*, while the highest ridges support a dense forest of *Abies Engelmanni*.

In descending the northeastern slope of the Owl Creek range, forming the western edge of the Big Horn basin, we come upon principal tributary streams draining the high mountain region to the west. In all these valleys, including Owl Creek, Gray Bull and Stinking Water, a uniform character of vegetation is observable, constituting a very distinct botanical district. On the steep gravelly ridges bounding the valley of Owl Creek was first noticed a very remarkable species of *Stanleya*, distinguished from all other known species of this interesting genus by the dense tomentose covering of its stem and foliage, and the sharply hastate form of its leaves. I have accordingly named it *Stanleya tomentosa*, n. sp. (see appendix, No. 13). This plant, then (July 20), in the full glory of its dense spike of cream-colored flowers, formed a conspicuous feature in the floral landscape. In this same locality was also found a new species of *Phelipæa*, which on account of its bright yellow color I have named *Phelipæa lutea*, n. sp. (see appendix, No. 202). This plant, which is met with growing in close proximity to the allied species, *Phelipæa fasciculata* Nutt., furnished an opportunity for a direct comparison of fresh living specimens, thus affording a more satisfactory means of distinguishing specific difference than could be derived from the dry faded plants. Along the borders of a dry ravine was collected a yellow flowered *Astragalus* with nearly mature fruit. This, on a cursory view, I noted as a form of *A. flavus* Nutt., previously collected on Green River. Prof. Gray, to whom specimens were sent under the above name, recognized its distinct character. I have therefore ventured to compliment the *actual* discoverer, as well as the chief elucidator of this difficult genus of western North American plants, by naming it *Astragalus Grayi*, n. sp. (see appendix). A side trip by a detached topographical party to the rugged peak named by Capt. Jones "Washakee's Needles" revealed, in a few fragments brought back by the party, a more distinct alpine flora than any yet seen, including *Douglasia montana* Gray, and a most singular depressed *Townsendia*, with its large single heads immersed in a globular mass of lanulose coated leaves. This, as far as the imperfect material affords the means of judging, is probably an undescribed species, to which the name of *Townsendia condensata*, n. sp., may be provisionally applied. In the lower mountain ranges there is a succession of charming subalpine meadows, set off with limpid lakes and traversed by clear ice-cold brooks, which, among other well known plants, furnished the following additions to our list, viz: *Astragalus oroboides* Hornem., *Œnothera breviflora* Torr. and Gray, *Aplopappus inuloides* Torr. and Gray, *Artemisia incompta* Nutt., and the singularly neat European species *Myosotis alpestris* L. In the valley of Stinking Water (a most inappropriate name for a clear mountain stream abounding in the finest trout), at a single locality, was collected the rare Chenopodiaceous plant characterized by Dr. Torrey as *Endolepis Suckleyi* Torr. This, in the unpublished revision of this family by Mr. S. Watson, is to be included in the genus *Atriplex* (*A. Endolepis* Watson, ined.). The excellent figure of this plant in Vol. xii, pl. 3, of "Pacific Railroad Reports," only fails to represent the straggling habit, densely divaricate branches and the blistered, mealy-dusted leaves of this species. It seems to affect a peculiar soil, so strongly impregnated with saline ingredients as to be entirely bare of all other vegetation.

In our course up the valley of Stinking Water there was little of botanical interest to attract the attention. The prevalent rocks were composed of a coarse igneous conglomerate, which weathered into the most fantastic shapes, presenting on either hand sharp pinnacles, toppling columns and chimney peaks; but the uniformity of soil derived from its disintegration was unfavorable to a rich development of floral forms. We accordingly note briefly the following as most abundant and characteristic: *Arenaria pungens* Nutt., var. *Astragalus microcystis* Gray, *Heuchera cylindrica* Dougl., *Bahia leucophylla* DC., *Stephanomeria paniculata* Nutt.

On reaching the upper portion of this valley, becoming more densely wooded, and frequently spreading out into open, grassy parks, a much more attractive and varied flora is brought to view. The pine woods, composed almost exclusively of *Pinus contorta*, with scattering trees of *Abies grandis*, and in the drier mountain slopes of *Abies Douglasii*, overshadow thick moss-bedded festoons of *Linnæa borealis*, associated with *Pyrola minor* L., and occasionally the more peculiar western form of *Pyrola dentata* Hook. Here too occurs abundantly *Antennaria racemosa* Hook., with sterile and fertile plants growing in distinct plots; scanty specimens were also collected of what is probably the little known *Antennaria luzuloides* Torr. and Gray. Everywhere on the moist, wooded slopes is a thick undergrowth of *Vaccinium myrtilloides* Mx. Rhamnus is represented by the well known northern form of *Rhamnus alnifolius* L. Her., and on the margins of ice-cold springs we meet with *Mimulus moschatus* Dougl. In ascending the higher mountain peaks, the rocky crags are brilliantly adorned with clumps of *Pentstemon deustus* Dougl., or the more showy *Pentstemon Menziesii* Hook. Along the borders of alpine brooks, together with the wide-spread *Mertensia Sibirica* Dougl., we meet with the showy *Mimulus Lewisii* Ph., so interesting in its association with the early explorer Lewis. *Mitella trifida* Gray is here found associated with the more common *Mitella pentandra* Hook. In similar localities, strangely remote from their original habitat, we meet with *Zauschneria Californica* Presl and *Kellogia galioides* Torr.! Near the bald alpine summits, where the ground is saturated from the recent melting of snow-drifts, grows the "California heath," *Bryanthus empetriformis* Gray, and here also at the most eastern locality yet noted was found a dwarf form of *Spraguea umbellata* Torr. The occurrence of so many peculiar Californian forms in such an isolated locality on the Atlantic slope is very suggestive.

On the high alpine crest at the head of Stinking Water, overlooking to the west the Yellowstone basin and its magnificent lake, a more alpine flora is exhibited, though composed mainly of dwarfed forms of plants met with lower down, as may be seen from the following list, noted down August 2, viz: *Arabis Drum-*

mondii Gray, *Arabis canescens* Nutt., *Draba alpina* L., *Smelowskia calycina* C. A. Mey., *Arenaria arctica* Stev., *Ivesia Gordoni* Torr. and Gray, *Potentilla dissecta* Pursh, *Astragalus alpinus* L., *Astragalus Kentrophyta* Gray, *Lupinus minimus* Dougl., *Sedum stenopetalum* Ph., *Townsendia* (not determined as to species. No. 145), *Erigeron compositum* Ph., *Senecio canus* Hook., *Achillea millefolium* L., *Phlox Douglasii* Hook., *Polemonium humile* var. (*P. parvifolium* Nutt.), *Mertensia alpina* Dougl., *Myosotis alpestris* L., *Eriogonum ovalifolium* Nutt.

In a concluding article, the general botanical features of Yellowstone Park and the head waters of Snake and Wind Rivers will be considered.

NOTE.—In order to render the determination of the new species mentioned in this and the preceding paper as complete as possible, and most convenient for reference, the descriptions will be given as an appendix to the concluding article.

NOTES UPON AMERICAN WATER BIRDS.

BY ROBERT RIDGWAY.

THE following are a few points which have been developed by our studies of the water birds in connection with the forthcoming "History of North American Birds," by Professor Baird, Dr. Brewer and the writer. They are published in advance of our work, that ornithologists may thus the sooner have the benefit of them.

In making a comparative study of the North American and European Grallæ, I have been struck by a very curious parallelism between certain congeneric or conspecific forms of the two continents. In many cases, the European analogues differ from their North American representatives chiefly, if not exclusively, in having the rump immaculate white, instead of spotted. The following table will show the extent of this parallelism, so far as I have had occasion to trace it.

American forms (rump spotted).	*European forms (rump immaculate).*
Rhyacophilus solitarius.	R. ochropus.
Gambetta flavipes.	G. stagnatilis.
Numenius Hudsonicus.	N. phæopus.
Hæmatopus palliatus.	H. ostralegus.

Ægialitis microrhynchus Ridgway. N. SP. Winter plumage similar to that of *Æ. semipalmatus*, but the cheeks white up to the eye, the white of the forehead less distinctly defined, grading insensibly into the gray posteriorly, and anteriorly reaching to the bill. Two outer tail feathers white, with a blackish transverse spot across the inner web. Much more slender than *Æ. semipalmatus*, and the bill of entirely different form, being short and exceedingly attenuated. Wing, 4·35; tail, 2·50; culmen, ·50; depth of bill, ·10; tarsus, 1·00; middle toe, ·65. Type, No. 39,523, Nat. Mus., San Francisco, Cal.; E. F. Lorquin.

Ægialitis melodus, var. *circumcinctus* Ridgway. Breeding plumage similar to var. *melodus*, but the black pectoral band complete across the jugulum, instead of being interrupted in the middle portion. Wing, 4·60; tail, 2·30; culmen, ·50; tarsus, ·85; middle toe, ·55. Type, No. 9,035, ♂ ad., Nat. Mus., Loup Fork of the Platte, July 8; Dr. F. V. Hayden. Length, 6⅓; extent, 14¼. *Habitat.* Plains between the Missouri River and Rocky Mountains.

The restricted var. *melodus* is found only in the Atlantic States.

Ægialitis Wilsonius, var. *rufinucha* Ridgway. Similar in color to var. *Wilsonianus*, but the tints much darker; sub-orbital region dusky, instead of whitish; occiput of the male deeply rufous: frontal white band narrower than the black one behind it. Wing, 4·50; tail, 2·25; culmen, ·80; tarsus, 1·20; middle toe, ·70. Type, No. 30,319, ♂, April, 1863, and 26,853, ♀, Dec. 20, 1861, Spanishtown, Jamaica; W. T. March. *Habitat.* Jamaica.

Ægialitis cantianus Lath., var. *nivosus* Cassin. (*Ægialitis cantianus* Coues, Key, p. 245.) This bird is distinguishable from the European form by the lores being destitute of a black stripe, instead of having a quite conspicuous one.

Ægialitis montanus Towns. (*Ægialitis Asiaticus* var. *montanus* Coues, Key, p. 245.) This species proves to be very distinct from that of Asia, to which Dr. Coues referred it on the authority of Schlegel. He has since informed us, after examination of specimens in the breeding plumage, that he is satisfied of the specific distinctions, our species having no pectoral black belt.

Ægialitis hiaticula Linn., var. *semipalmatus* Bonap. The American bird differs from the European merely in lacking the white post-ocular space in narrower pectoral band, and in its slightly smaller size.

Gallinago scolopacina Bonap., var. *Wilsonii* Bonap. The American form of this species is distinguishable from the European merely by slight differences in proportion, being smaller in general measurements, especially in length of bill and tarsus, with comparatively longer wing.

The *G. nobilis* Scl. and Salv., of northern South America, *G. Paraguæ* Vieill., of the southern portion of the same continent, and *G. Australis* Lath. of Australia, seem to be also referrible to the same species, though slightly distinguished by the attenuation of the outer tail feathers, thereby showing an approach to *G. stenura* Kuhl, of the Malayan region, which, however, has twenty-six, instead of fourteen to eighteen rectrices.

Limosa rufa Temm., var. *uropygialis* Gould. The differences between this race and that of Europe are very slight. The Alaskan bird is merely paler colored on the lower surface, and has the axillars and rump with dusky prevailing, instead of mostly white.

Ibis falcinellus (Linn.). (*Ibis Ordii* Bonap. et Auct.) The glossy Ibis of the West Indies and the eastern United States is absolutely indistinguishable from that of Europe. A close examination of nearly a hundred American specimens, reveals the fact that this continent contains at least one, and probably two, species distinct from the *I. falcinellus* or *I.* "*Ordii.*"

The three species found in America may be distinguished as follows: —

A. Adult with the head, neck and lower parts chestnut. Young with these parts streaked white and grayish dusky, the metallic reflections of the upper parts with varying lights of purple, violet and green, the lesser wing coverts with a patch of chestnut.

a. Head dusky around the base of the bill, which is dull greenish in the adult. *Habitat.* Old World, West Indies, and Eastern U. S. 1. *I. falcinellus.*

b. Head white all around the base of the bill, which is dusky red in the adult. *Habitat.* Whole of tropical America, and middle province of U. S., from Chili and Buenos Ayres to the Columbia river. 2. *I. guarauna.*

B. Adult with the head and lower parts as in the young of the preceding species; the metallic reflections of the upper parts of a uniform shade of vivid bronzed green; lesser coverts without a chestnut patch. *Habitat.* Pacific coast of America, from California to Chili; western portion of the Great Basin (Humboldt river, Ridgway). 3. *I. thalassinus.*

Other characters of as great importance accompany the above, while their constancy is shown by large series of each species. The chief synonymy of these species stands as follows: —

1. *Tantalus falcinellus* Linn., S. N. I., 241. (*Ibis Ordii* Bonap., List, 1838. Baird, B. N. Am., 1858, p. 685. In part only!)

2. *Scolopax guarauna* Linn., S. N. I., 242. (*Tantalus chalcopterus* Temm. pl. col. "*Ibis Ordii* Bonap.," Baird, B. N. Am., 1858, p. 685. ??? *Tantalus Mexicanus* Gmel., S. N. I., 1788, 652.)

3. *Ibis guarauna* Baird, B. N. Am., 1858, pl. lxxxvii. Id. Catal. N. Am. B., No. 500*a*. *Ibis thalassinus* Ridgway, Rep. U. S. Geol. Expl. 40th par. (In press.)

Rallus elegans, var. *obsoletus*, Ridgway. Differing from var. *elegans* in being more grayish above, where the stripes are nearly obsolete, and dark brown, instead of deep black on a yellowish olive ground. Rufous of the lower parts paler and duller. Wing, 6·30; tail, 3·50; culmen, 2·25; bill, ·50 deep at base; tarsus, 2·10; middle toe, 2·00. Type, 6,444, San Francisco, Cal., March, 1857; Dr. Suckley. *Habitat.* Coast of California.

Rallus elegans var. *tenuirostris* Lawrence. Similar in colors to var. *elegans*, but smaller, and with very much slenderer bill. Wing, 5·90; tail, 3·25; culmen, 2·00; bill, ·35, deep at base; tarsus, 1·80; middle toe, 1·70 (No. 52,849, Valley of Mexico; Col. A. J. Grayson). Type, from city of Mexico, in cabinet of Mr. Lawrence.

Porzana Jamaicensis, var. *coturniculus* Baird. Differing from var. *Jamaicensis* of southeastern United States, West Indies and South America, in smaller size, and more uniform colors. Back without white specks. Wing, 2·50; culmen, ·52; bill, ·15 deep at base; tarsus, ·80; middle toe, ·80. Type, No. 12,862 Nat. Mus., Farallone Islands, coast of California; T. G. Martin. *Habitat.* Farallone Islands, California.

Anas obscura, var. *fulcigula* Ridgway. Differing from var. *obscura* in lighter and much less uniform colors, and unstreaked deep buff throat. Deep ochraceous borders to the feathers very broad, on the lower surface almost as wide as the dusky medial streaks. Wing, 10·30; tail, 5·00; culmen, 2·05; width of the bill, ·90; tarsus, 1·70; middle toe, 1·90. Bill olive color (olive-yellow in life?); feet, deep orange-red. Type, No. 1,748, Mus. R. Ridgway, St. John's river, Florida. C. J. Maynard. *Habitat.* Florida; permanent resident.

A specimen in the National Museum (No. 61,360) from the St. John's River, collected by Mr. G. A. Boardman, is exactly similar.

NOTES FROM THE JOURNAL OF A BOTANIST IN EUROPE.

BY W. G. FARLOW, M.D.

PART II. NORWAY, ETC.

I LANDED at Christiania upon a high holiday, one rather striking to a pilgrim from the new world. The people were celebrating the two thousandth birth-day of Norway! I found Professor Schübeler at home; and the next day he showed me through the Botanic Garden and the University. Although the Garden is poor enough compared with that of Lund, yet it is good considering the latitude, and the conservatories appeared to be as large and as well filled as those at Cambridge. The university buildings are well situated, and I should think more extensive than those at Cambridge. The Professor is a man of boundless energy, and is making the most of narrow means and a poor climate. He gave me a list, by no means a long one, of all the American trees in the garden. It would be an easy and excellent thing for an American correspondent to double and triple their number. Seeds and cones are desired rather than young plants, for obvious reasons. There is the same confusion in the north of Europe of our two spruces as that which prevails, or till lately prevailed, in the nurseries and plantations at home. The plantation of "*Abies alba*" which Professor Agardh showed me at Lund was mostly in fruit, and every tree of it *A. nigra;* while here, Prof. Schübeler's only tree of "*Abies nigra*," also in fruit, proved to be *Abies alba.* The herbarium here is of no special consequence.

What most interested me, besides a few algæ given me from Lyngbye's collection, valuable as souvenirs, was a museum of the economical products of Norway, especially the grains, entirely prepared by the present Professor; and a very interesting chart made by him of the arable lands of Norway. The cultivable grounds appeared as mere lines, almost as narrow as the rivers on a map. As I subsequently found, fully nine-tenths of the country consists of steep rocky mountains, and only the banks of the rivers are fertile. The perseverance of the people is wonderful. Every spot at all level is closely cultivated. Tracts of half or a quarter of an acre, up on the sides of the mountains, are covered with barley; and available spots on the fiords, accessible only by some miles of hard rowing, are planted with oats. The grain is stacked in little heaps in the fields and a sort of rail fence is made to which the hay is fastened to dry. In many places the hay has to be carried down the mountains on the peasants' backs. I can't imagine how they get hay enough to keep their cattle through the winter. Southern Norway, moreover, is more like New England than any country I have seen, only more mountainous. The houses are wooden and painted white, and there are rail fences. Cherries and a very few apples are the only fruits. The wild strawberries are delicious, but the natives prefer the molteberry which is quite insipid. It flourishes high up in the mountains where only *Salix glauca* and *Betula nana* grow. I was surprised to find that the *Abies excelsa*, or Norway spruce, is not a mountain tree. It is not a handsome tree till you reach the valleys of southern Norway. *Pinus sylvestris* grows alone on the higher mountains and is far from beautiful. The poverty of the forests in species is striking; nothing but birches, alders, and one or two conifers.

The herbaceous plants were more varied, and very attractive to me; possibly the more so because I had to puzzle them out with the only book I had, Hartmann's Flora in Swedish, which I can't read, but could guess at the botanical terms. Fortunately at the top of the Fille-field I met a botanist who spoke a little German. *Erica tetralix* is to me the most beautiful plant in Norway. *Digitalis purpurea* here grows on the edge of the glaciers and *Gentiana nivalis* by the roadside. *Aconitum septentrionale* abounds everywhere. I was surprised to find that the hood of every flower, in a hundred or more I examined, had been perforated by some insect, which in this way sought the honey.

I hoped to find some good algæ, especially at Molde, but was unsuccessful. After two days' contemplation of *Fucus nodosus* and *vesiculosus* in various forms, I passed on to Bergen, the rainiest town in Norway and, I believe, in the world. There the water is warmest when the wind is north, owing to the Gulf Stream, and, whichever way the wind blows, the odors are horrible.

As to the scenery, it is always pleasant, sometimes very grand. The Romsdal is a very wild and gloomy pass about twenty miles long, and perfectly dripping with lovely waterfalls and cascades.

The peaks are sharper than anywhere else and covered with snow. The view of the Romsdal mountains from Molde is the finest distant view I saw in Norway, where distant views are scarce owing to the narrowness of the valleys. From Bergen, I went up the Hardanger Fiord and into the Sör Fiord to Odde. The fiords are the finest things in Norway, mountains two or three thousand feet high, sometimes more, coming straight down into the greenest of water. You sail on for hundreds of miles, the scenery varying from grand to grander. The Sör Fiord is particularly fine, the water is narrow and the mountains black and steep, with the Folgefond glacier on one side hanging over the cliffs, and coming down the ravines. From Odde I visited the Skaggindal foss, a pretty waterfall pouring into a beautiful lake; and a glacier in the vicinity, the first I had ever seen close at hand. Notwithstanding all I had read and heard I was astonished at the color of the ice which, without exaggeration, was as deep as sulphate of copper. It advanced fifty feet last year.

At St. Petersburg the attractions for the botanist centre in the Botanical Garden, with its twenty-five well filled conservatories, a collection of hardy plants and trees of remarkable extent, considering the climate, and a large herbarium and library attached—all under the immediate care of Dr. Regel, formerly of Zurich, a scientific botanist as well as gardener. Dr. Trautvetter, however, is the official head of the establishment. There is a smaller but a choice herbarium at the Imperial Academy of Sciences, which since Ruprecht's death has been in charge of Dr. Maximowicz, who has travelled and collected largely in Mandchuria and Japan, and is now engaged upon a flora of the latter country. Though still young he has a high reputation as a botanist, and is an admirable man. To add to my satisfaction and comfort, he spoke English with facility. My special object was to examine the algæ of northwest America described by Ruprecht. These are in the Academy's herbarium, in the condition in which they were left by him, without much arrangement.

Of Moscow, with its domes and shrines and dingy splendors, I have nothing to say botanically; and the same of the continuous railway journey of one thousand three hundred miles from thence to Berlin, without sleeping cars. On arising I found to my disgust that the three emperors were expected in two days, and not a room to be had in any hotel. At length, however, I found a lodging close to the Linden. On calling at Professor Braun's I learned that he was in Brandenburg, happily away from the heat and crowd. Never before have I so suffered with the heat, which for six days has been intense; so great that walking was almost impossible, and the dust made the riding almost insufferable. The crowd has been growing greater and greater, but culminated last night when there was a serenade by seven hundred musicians in front of the palace. I think I should enjoy Berlin in winter, but now I am tired of the heat and dust, and emperors; and shall leave at once for Cologne on my way to Strasburg.

REVIEWS AND BOOK NOTICES.

New German Botanical Manuals.*—The two botanical text-books named below have now superseded all others in Germany. The first, uniform with a zoology by the same author, is admirably adapted for schools and colleges, being compact, clearly and concisely written, and copiously illustrated with woodcuts. All the subjects of any general botanical interest are touched upon, and, for this reason, it is an excellent book for amateurs who wish to keep up to the present state of the science without taking the time and trouble necessary for learning, practically, microscopic and systematic details. The greatest advance in botany, recently, has been made in the departments of anatomy and lower cryptogams where, unfortunately, more knowledge of the microscope is necessary than is possessed by the majority of botanical readers. In the book of Thorné, the frequent woodcuts take the place of microscopic work as far as such a thing is possible. On the whole, this is the best elementary botanical text-book which has yet been published in Germany.

The second work, although called a text-book, partakes much more of the character of an encyclopædia. In consequence partly of the high reputation of the writer as a vegetable physiologist, the book has had an almost unprecendented sale, the third edition being already nearly exhausted and a separate edition of the second part, relating to vegetable physiology, having just made its appearance. The proportion of those who buy the book and actually read it, however, is decidedly smaller than in the case of the first mentioned book. It is a work which gives an excellent summary of the present state of botany as it exists in Germany, particularly, of the results of recent studies in the cryptogams, and, as such, is a valuable book of reference for the special student and professor. It is much too intricate and full of microscopic details to be easily intelligible to the general reader. It is by no means the case, as some suppose, that the average botanical student in Germany is in a condition to profit by Sachs' Lehrbuch. In many places, without previous study of the lower forms of vegetable life, the book is quite incomprehensible. The text and woodcuts are excellent.—W. G. F.

---

* Lehrbuch der Botanik von Dr. Otto Wilhelm Thorné 2te auflage 1872. Lehrbuch der Botanik von Prof. Julius Sachs. 3te auflage 1873.

THE MOLLUSKS OF WESTERN NORTH AMERICA.*—Under this title Dr. Carpenter reprints the reports made by him to the British Association, with other papers, which will make the volume of much value to malacologists.

BOTANY.

WERE THE FRUITS MADE FOR MAN, OR DID MAN MAKE THE FRUITS?—These need not be taken as mutually exclusive propositions; for as "God helps those who help themselves," and man's work in this respect is mainly, if not wholly, in directing the course or tendency of Nature, so there is a just sense in which we may say "the art itself is Nature," by which the greatest triumphs of horticultural skill have been accomplished. Moreover I am not one of those naturalists who would have you believe that nothing which comes by degrees, and in the course of nature, is to be attributed to Divine power.

The answer I should give to the question, as we thus put it, is:

1. Some fruits were given to man as they are, and he has only gathered and consumed them. But these are all minor fruits, and such as have only lately come within the reach of civilized man, or are not thought worth his trouble. Huckleberries and cranberries, persimmons and papaws are examples, taken from this country. Whether even such fruits have or have not been under a course of improvement, irrespective of man, is another question.

---

* Smithsonian Miscellaneous Collections, 252. Washington. Dec., 1872, 8 vo. pp. 325, 121.

2. Others have come to man full flavored, and nearly all that he has done has been to increase their size and abundance, or extend their season. Currants and gooseberries, raspberries and blackberries, chestnuts, and above all, strawberries, are of this class.

3. But most of the esteemed and important fruits, as well as the grains, have not so much been given to man as made by him. The gift outright was mainly plastic—raw material, time and opportunity. As to the cereal grains, it is only of the oat that we probably know the wild original; of wheat there has been an ingenious conjecture, partly, but insufficiently, confirmed by experiment; of the rest, no wild stock is known which is not most likely itself an escape from cultivation. Of some of them, such especially as maize, not only can no wild original be indicated, but in all probability none exists.

So of the staple fruits; of some the wild originals can be pretty well made out; of more, they are merely conjectural; of some they are quite unknown and perhaps long ago extinct.

To cite examples in confirmation or illustration of these points, to note how very ancient some of our varieties of common fruits are, and how very recent certain others—to consider how they have originated, with or without man's conscious agency, and how they have been perfected, diversified and preserved, mainly under man's direct care—would be to expand this note into an essay, and yet to say nothing with which pomologists are not familiar.

It would be curious to speculate as to what our pomology would have been if the civilization from which it, and we ourselves, have sprung had had its birthplace along the southern shores of our great lakes, the northern of the Gulf of Mexico, and the intervening Mississippi, instead of the Levant, Mesopotamia and the Nile, and our old world had been open to us as a new world less than four hundred years ago.

Seemingly, we should not have as great a variety of choice fruits as we have now, and they would mostly have been different, but probably neither scanty nor poor. In grapes, at least, we should have been gainers. Our five or six available species, of which we are now just beginning to know the capabilities, would have given us at least as many choice sorts and as wide a diversity as we now have of pears; while pears would be a recent acquisition, somewhat as our American grapes now are. Our apples would have been developed from *Pyrus coronaria:* and might have equalled anything we actually possess from *Pyrus Malus* in flavor, though perhaps not in variety, if it be true, as Karl Koch supposes, that the apples of the orchards are from three or four species. At least one of our wild hawthorns, *Cratægus tomentosa*, in some varieties, bears a large and delicately flavored fruit, evidently capable of increase in size; it might have been in the front rank of pomaceous fruits. In a smaller way our service-berry would have been turned to good account. Our plums would have been the progeny of the *Chicasa*, the beach plum, and our wild red and yellow *Prunus Americana*, which have already shown great capacity for improvement; our cherries might have been as well flavored, but probably not as large as they now are. But instead of peaches and figs, we should be discussing manifold and most luscious varieties of persimmon and papaw, the former probably equal to the *kaki* just acquired from the far east. As to strawberries, gooseberries and currants, we should have lost nothing and gained something, as we possess several species besides the European types themselves; as to blackberries and raspberries we should have been better off than now, by the earlier development and diversification of our indigenous species. And we might have had all our finest strawberries a thousand or more years ago, these having come from our American types, *Fragaria Virginiana* with its varieties (which, as well as the old world *F. vesca*, occurs all across the continent), and *F. Chilensis* which ascends the Pacific coast to Oregon.

Then we should consider how much earlier our race, with an American birthplace, would have been in possession of tomatoes, of the pineapple, of the cherimoyer and the other custard apples, of the star-apples and other sapotaceous fruits, of chocolate, of Lima beans in all their varieties, of peanuts; not to speak of potatoes, sweet potatoes, and "Jerusalem" (that is, girasola or sunflower) artichokes: the last supplemented by our ground-nut (*Apios tuberosa*) would have been the first developed esculent tubers, and would probably have held their place in the first rank along with potatoes and sweet potatoes of later acquisition.

Among the causes and circumstances which have given to the fruits of temperate climates of the old world their preëminence, *opportunity* is one. How many potential fruits of value lie undeveloped in this country we know not, and now shall never know. They have lost their opportunity. Necessity, which is the mother of pomology as well as of other invention, has been fully supplied out of other accessible, and in some cases no doubt originally better, materials.

There are some, however, for which evidently "a good time is coming." Of these, our wild grapes are foremost. They have such a start already, and seedlings, whether from crosses or otherwise, can be produced and selected and reproduced in so short a space of time, that they will probably have achieved their position when the American Pomological Society holds its centennial celebration.

Blackberries, from *Rubus villosus*, are in similar case; and if due attention be paid to the low blackberry or dewberry, and to the sand blackberry of New Jersey and farther south, the foundation for a greater diversity of excellent sorts will be laid.

As to cranberries, already an important staple, increase of size and abundance of production are all that are to be expected. It is easier to bring about improvements in the direction of sweetness than in that of acidity. Huckleberries, also, have probably nearly reached their perfection unassisted.

A few wild fruits may be mentioned which manifestly have great capabilities, that may or may not be developed in the future. The leading instances in my mind are the persimmon and the papaw,—not the true papaw, of course, which we have in Florida, but the *Asimina* or western papaw, so called. Both persimmons and papaws are freely offering, from spontaneous seedlings, incipient choicer varieties to be selected from; both fruit when only a few years old, thereby accelerating the fixation of selected varieties into races; and both give fruits of types wholly distinct from any others we possess of temperate climates. He that has not tasted a *kaki* has no conception of the capabilities of the *Diospyros* genus. The custard apples of the West Indies give some idea of what might be made of our papaw, when ameliorated by cultivation and close selection from several generations. I have understood that one of the veteran pomologists of the country, Dr. Kirtland, of Ohio, a good while ago initiated a course of experiments upon the papaw in this regard; it would be well to know with what success, and whether the breeding and selection have been continued through successive generations.

Our American plums, already mentioned, have for many years been in some sort of cultivation, and have improved upon the wild forms; but I suppose they have not been systematically attended to. Their extreme liability to black-knot and other attacks renders them for the present unpromising.

Finally, if pomology includes nuts, there is a promising field uncultivated. Our wild chestnuts are sweeter than those of the old world; it would be well to try whether races might not be developed with the nuts as large as *marrons* or Spanish chestnuts, and without diminution of flavor. If we were not too easily satisfied with a mere choice among spontaneous hickory nuts, we might have much better and thinner shelled ones. Varying as they do excessively in the thickness of the shell and in the size and flavor of the kernel, they are inviting your attention, and promising to reward your care. The pecan is waiting to have the bitter matter between the shell and the kernel bred out; the butternuts and black walnuts to have their excess of oil turned into farinaceous and sugary matter, and their shells thinned and smoothed by continued good breeding; when they will much surpass the European walnut.

All this requires time, almost unlimited time; but it is not for those who are enjoying the fruits which it has taken thousands of years to perfect, to refrain from the good work which is to increase the enjoyments of far future generations.—ASA GRAY, *in Horticulturist.*

ZOOLOGY.

CAPTURE OF A GIGANTIC SQUID AT NEWFOUNDLAND.—We print the following letter from Mr. Murray, of the Canadian Geological Survey, kindly forwarded to us by Professor Agassiz shortly before his death:—

ST. JOHN, NEWFOUNDLAND, NOV. 10, 1873.

My Dear Sir:—The following account of a remarkable marine monster, which made its appearance off the shores of this island, and of a severed arm or tentacle of the same, now in my possession, will I dare say be interesting to you, and also to Prof. Agassiz, to whom I should like to offer it.

On or about the 25th of October last, while a man by the name of Theophilus Picot was engaged at his usual occupation of fishing, off the eastern end of Great Bell Island in Conception Bay, his attention was attracted to an object floating on the surface of the water, which at a distance he supposed to be a sail, or the *débris* of some wreck, but which proved upon nearer inspection to be endowed with life. Picot, on observing that the object was alive, to satisfy his curiosity pushed his boat alongside, and I believe struck at it with an oar or boat-hook, whereupon the creature's fury seemed to be aroused, and it struck at the bottom of the boat with its beak, and immediately afterward threw its monstrous tentacles over the boat, which probably it might have dragged to the bottom had not Picot with great presence of mind severed one (or more) of the tentacles with his axe. A part of this tentacle or sucking arm I have now in my possession, immersed in spirits. I send you with this letter a couple of photographs of the said tentacle and a few of the small denticulated sucking cups, all of which I hope will reach you safely.

Picot's description of this great squid, cuttle or devil-fish is this. He represents the body of the animal to have been about sixty feet long, and its general diameter as not less than five feet. The breadth of the tail he represents as at least ten feet. He states that when the creature found itself mutilated it made off backwards or tail foremost, after the manner of squids, darkening the water over a large space with inky emissions. The enormous proportions given above might appear to be exaggerations, were they not to a great extent borne out by the fragment of the animal which was severed, and of which the photograph will give you a fair idea. The tentacle measured on the 31st of October, when I first saw it, after it had been several days in strong brine and shrunk in consequence, seventeen feet; but was said to have measured nineteen feet previously. When it was first landed at a place called Portugal Cove, in Conception Bay and within nine miles of St. John, some six feet was cut off the inner end of this arm, and Picot asserts that the original incision was at least ten feet from its articulation with the body. Accordingly the whole length of the said arm must have been from thirty-three to thirty-five feet. The beak or bill of the creature Picot described as being about the size of a six gallon keg.

The Rev. Mr. Gabriel now residing at Portugal Cove, but who formerly resided at a place called Lamalein on the south coast of the island, states that, in the winter of 1870 and 1871, two entire cuttle or devil-fish were stranded on the beach near that place, which measured respectively forty and forty-seven feet.

The man Picot says he saw the animal very distinctly for some time after it had been mutilated, swimming stern foremost with its tail above the water's edge, and that its general color was a pale pinkish, resembling that of the common squid.

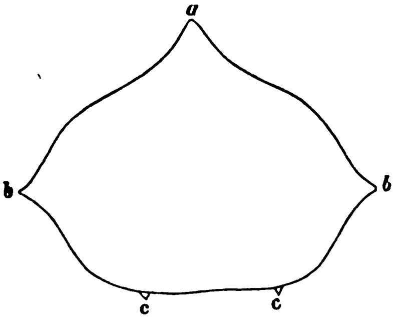
The following is an exact copy of the memoranda I made on first inspecting this remarkable tentacle on the 31st of October. The total length of the fragment from the last incision to the extremity, seventeen feet. The extremity of the arm or terminating two and one-half feet is flattened, and somewhat in shape like a narrow paddle, tapering toward the end to a sharpish point. The thickest part of this terminal appendage is about six inches in circumference.

The inner fourteen and one-half feet is rounded in form, varying in thickness from three and one-half to four inches in diameter, or about the size of an ordinary man's wrist. On what I shall call the ventral side of this fourteen and one-half feet, there is a set of small tubercles or mammillary processes, which, at the end nearest the articulation, are about two feet apart, but become much closer and more numerous towards the extremity. Some small valve-like sucking denticulated cups are distributed along the area near the tubercles. Examples of these you will find in the small pill-box.

At the extreme point of the paddle-shaped extremity, and also at its junction with the rounded part, there is a cluster of small denticulated sucking cups, each cluster containing from fifty to seventy individual cups. The smallest of these is not larger than the head of a pin. The broad paddle-like part between the two clusters is armed with a double row, twelve in each, of gigantic suckers, without teeth, each individual measuring about one and one-fourth inches in diameter.

A section across the middle part of the arm is of the following form, somewhat flattened (Fig. 44).

Fig. 44.



a, dorsal ridge; *b*, flanges of thin membranes; *c*, ventral tubercles.

The whole tentacle, as coiled up for the photograph, measured two feet, four and one-half inches on the longer diameter. The photograph is one-fourth the natural size.

Hoping I have made myself intelligible and that I may hear from you shortly what Agassiz says about the singular creature, I am, my dear sir, yours very truly, ALEX. MURRAY."

The following second letter from Mr. Murray to Prof. Agassiz seems to refer to another individual, but much smaller: —

"I send you with this two photographs of the creature in question, one being the head and tentacles, the other the body. The latter part has unfortunately been a good deal mutilated while being extricated from the net in which it was caught. The head was cut off and the eyes destroyed, but I hope you will find the remainder sufficiently well preserved for description and restoration.

My own descriptive memoranda are as follows: — Caught at Logia Bay, near St. John, Newfoundland, Nov., 1873. Total length of body seven feet, circumference five feet, tail fan-shaped, pointed at the middle extremity, and between extremes of extended appendages measures upwards of two feet. Two tubes run the whole length of the body, one of which contains the inky fluid, the other water. The eyes of this individual have been destroyed, but the socket of one is attached to the neck, the diameter of which is four inches. In the centre of the head, there is a powerful beak of black and orange color. In shape the beak exactly resembles a parrot's.

Around the head there are eight large arms each from six to seven feet in length: two of which are nine inches in circumference; two of eight inches; and five of seven inches. These tentacles are covered with suckers on the lower side for their whole length, all denticulated, about one hundred sucking cups upon each arm. There are also two long slender tentacles, each measuring twenty-four feet in length, the average circumference of the rounded part of which is under three inches. The extremities of these longer tentacles are paddle-shaped, and armed with about eighty denticulated suckers. In this case both the greater and the smaller suckers are armed with teeth.

Photographs taken by Messrs. Parsons and McKenna, St. John, on Tuesday, Dec. 2, 1873. A very respectable person, by the name of Pike, informs me that he has seen many of these gigantic squids upon the coast of Labrador; and that he measured the body of one eighty feet from beak to tail. He also states that a certain Mr. Haddon, a school inspector of this place, measured one ninety feet. He tells me, moreover, that the monsters are edible.

The man Picot who produced the first specimen of a tentacle, stated to Mr. Harvey that he had his boat alongside of the animal; that the boat was twenty feet long, and, as near as he could judge, it was about one-third the entire length of the creature's body."

[We would refer our readers to an account of colossal cuttle-fishes on p. 87 of vol. vii of this journal, and the notice of *Architeuthis dux* found in the North Atlantic. Professor Verrill of Yale College writes us that he has received both jaws and two suckers of the Newfoundland cuttle-fish. The beak, he says, agrees nearly with the figure of that of *A. dux*, on p. 93, of vol. vii, but the jaws are somewhat larger, he thinks.—EDS.]

A NEW (?) ÆGERIAN MAPLE BORER.—In the description of a supposed new maple borer on page 57 of the January number, I recognize an old acquaintance which vies with *Chrysobothris femorata* in killing the shade maples of the Mississippi Valley, and which is not unfrequently found in the eastern states. I have been familiar with its work for nine years, and it has long been known as *Ægeria acerni* Walker (*Trochilium acerni* Clem.).—C. V. RILEY, *St. Louis*, *Jan.* 20, 1874.

THE ANATOMY OF WORMS.—Claparède's elaborate posthumous work with fifteen plates, on the anatomy of the sea worms, appears in the "Mémoires de la Société de Physique et d'Histoire Naturelle of Geneva.

GEOLOGY.

THE N. W. WYOMING EXPEDITION.—The summer of 1873 is noted for the number of expeditions which were organized for the purpose of explorations in the territories, and the almost uniform success which has resulted, from a scientific point of view. Among all of these none has perhaps attracted so little attention as the small band which quietly set out from Omaha on the second day of last June, with the purpose of accomplishing, with the smallest possible appropriation, what three successive parties, led by the most intrepid and daring explorers of the western country, had pronounced impossible.

This expedition, in a tour of some eight or nine hundred miles, made a careful topographical, geological and botanical survey of a large portion of unexplored territory in N. W. Wyoming, adjacent to the National Park, and connected the whole with the work of previous explorers by a complete reconnoissance of the park itself. The principal geological results have already been published in outline,* and the writer has prepared a paper for the NATURALIST, relating more especially to the features of the Yellowstone Park, I must therefore content myself, in this place, with a very brief account of the most important results of the expedition.

Besides the unravelling, in a great measure, of the complicated mountain system of the great central water-shed of North America, the head waters of the three great rivers which here diverge, as from a focal point,† were explored and mapped, and several new passes were discovered, through the rugged walls of the Sierra Shoshone‡ mountains. After a successful tour of the whole of the reserved tract, during which ample collections were made, the party ascended the valley of the Upper Yellowstone River, rediscovering the "Two Ocean Water" of Lewis and Clarke, which has recently been pronounced a myth. This interesting phenomenon is nothing more nor less than a mountain stream which, flowing down the mountain side, at its base splits quite curiously into two distinct streams, one going northerly to the Upper Yellowstone River, thence *via* the Missouri and Mississippi rivers to the Atlantic waters; the other, flowing southerly, reaching the Pacific ocean by way of Snake River and the Columbia.

---

*American Journal of Science, December, 1873.

†Missouri, Colorado, and Columbia rivers.

‡Name given by Capt. W. A. Jones, commander of the expedition, to the snow-clad walls upon the east of the Yellowstone Lake.

But the greatest geographical result, as well as the most important for other reasons, was the discovery of a pass through the Wind River range of mountains, at its northern limit, which renders the park accessible from the head of Wind River. This was one of the main objects of the expedition, the "*impossibility*" of its forerunners.

While it is impossible to give, in detail, the work of the several departments, it may be said that all was accomplished in the most thorough manner, as the reports will show when completed. In geology, the collections comprise specimens from all of the western formations, from the metamorphic rocks to the most recent, including material of volcanic origin and from the drift, as well as geyser and hot spring deposits in quantity. Many of the recent products are fully as interesting as those of an older date, and the surface and dynamical geology of this region present a vast field for study.

I have dwelt upon the geology, because more specially interested in that subject, but the botanical and other results are no less interesting. No zoölogist accompanied the expedition to collect, but Mr. J. D. Putnam, assistant to Dr. Parry, obtained a number of insects besides attending to his regular duties. I also noted the larger and more common animals which I observed from time to time. Dr. Heisman, surgeon to the expedition, collected specimens of the water and many of the deposits of the springs and geysers, for analysis.

For a more extended account of these explorations I must refer to the articles before mentioned.—THEO. B. COMSTOCK, *Geologist.*

MONKEYS IN THE AMERICAN MIOCENE.—Prof. Cope, while investigating the palæontology of Colorado in connection with Hayden's geological survey of the territories during the past season, detected the remains of what he states to be a quadrumanous mammal allied to the lemurs. It has been named *Menotherium lemur-*

inum, and was as large as the domestic cat. The existence of peculiar forms of lizard, serpents and lemurs constitutes points of resemblance to the Eocene fauna of Wyoming not previously recognized in our Miocene formations.

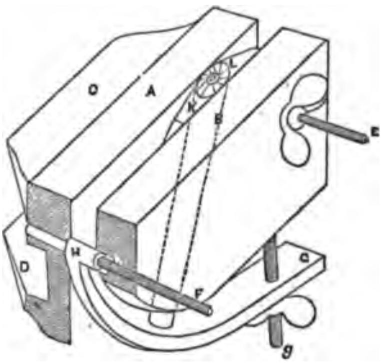
THE GENUS PROTOHIPPUS.—This form of horse is characterized, according to Leidy, by a peculiarity of the permanent teeth which belongs to the temporary teeth of *Equus*. Prof. Cope has recently obtained nearly complete skeletons of several species, and finds that like *Hippotherium* they have three toes. He describes a new species, *P. sejunctus*, in which the legs are considerably longer and the head relatively larger than in the true horse, having thus proportions of body, as well as dentition resembling the colt.

MICROSCOPY.

A NEW FORM OF MICROTOME.—The microtome in common use consists essentially of a round hole in which the object is wedged, and forced above the guiding surfaces of the instrument by a screw acting beneath. Various forms are to be found that differ in size, but agree in principle, that of Beck being, perhaps, as convenient as any, though I have used one consisting of a disk furnished with a graduated series of holes and revolving so that any desired aperture could be brought over the screw, which, for making sections of stems was much more desirable. Dr. Hunt of Philadelphia has the apparatus set in a freezing box, thus making a refrigerating microtome, and by bedding animal structures in soap, which expands and fastens them more strongly than paraffine or other compositions used for that purpose, it answers very well.

But having occasion to cut a number of plant tissues, especially fern stems, I found it very desirable to have oblique sections, to show more perfectly the scalariform tissue, and the only way I could accomplish this with the ordinary instrument was to cut a diagonal crease in the flat sides of a split cork, to hold the stem, and, inserting the cork, cut the whole as one piece and sort out the ferns from the cork. Some tolerable sections were obtained in this way, but the results were generally so unsatisfactory that I was led to devise a new instrument capable of more adaptation, the construction of which is shown in the accompanying figure. *A* and *B* are guiding surfaces (in my instrument of glass), formed on two parallelograms of metal, the outside of *A* carrying lips *C* and *D*, the latter provided with a thumbscrew by which it can be fastened to a table. The front ends of *A* and *B* in the drawing are cut off to show the arrangement of the rods *E* and *F* that are firmly inserted in *A*, but permit *B* to slide freely on them. They are threaded on the outer ends and have thumbscrews by which *B* can be pressed to *A*; the thumbscrew on *F* not shown. *H* is a sleeve on *F* forming one end of the curved lever *G*, that has a motion regulated by the screw *I* hanging from the rod *E*.

Fig. 45.



To use the instrument some narrow pieces must be provided equal in length to the depth of the instrument. These pieces I call blanks, and they may be of rubber, paper, or wood, slightly thicker than the stem to be cut, which stem should not be more than half as long. A follower is also required as large as the stem and so long that with the stem it will reach from the guiding surfaces to the lever *G*, when the latter is pressed down as far as *I* permits. Laying the instrument on its side remove *B*, lay the stem on *A*, at any desired angle to the guide, bring a blank up to it on either side, insert the follower, replace *B*, screwing it up tight, and by the screw *I*, which should be very fine, the lever *G* forces the follower and stem above the guides as in the old instruments. For animal tissues, they are bedded in soap in little paper boxes, and when cold the mass is treated as a stem. A vessel with an inner lip to hold the microtome, and screw working through the bottom, makes it refrigerating. Longitudinal sections of wood are beautifully cut, by clasping one end a little tighter than the other, against which the follower works, the section thus commencing at nothing. Of course a variety of followers and blanks can easily be provided to suit various cases, and a little manual tact is required but in my hands I find it takes less time for manipulation than any other instrument, with a range of work before impossible.—WM. H. SEAMAN, *Howard University*.

NOTES.

We make the following extract from Mr. Milne Holme's late address before the Edinburgh Geological Society: —

"In America every state has its state geologist, with assistants, whose duty it is not merely to map discoveries by others, but to make researches. A specimen of the work done by one of the American state geologists, I have brought here this evening. It far exceeds, in fulness of detail and artistic skill, anything which I have seen produced by our government surveyors."

By the report of the Director of the New York Central Park menagerie, we notice that the number of animals on exhibition during 1873 was eight hundred and six, an increase of two hundred and five over the previous year. Among them are a manatee and a tapir, the first of the species ever imported to this country.

Prof. Asa Gray has been appointed one of the Regents of the Smithsonian Institution, in place of the late Prof. Agassiz.

ANSWER TO CORRESPONDENT.

H. K. H., Mich. — The caterpillar you sent formed a cocoon in the box and disclosed the moth. — *Tolype velleda* Stoll.

BOOKS RECEIVED.

Contributions to Solar Physics. By J. Norman Lockyer. 8vo, pp. 676. With 175 figs. 6 plates. MacMillan and Co. Price $10.00. London, 1874.

Fourth Annual Report of the Commissioners of Fisheries of the State of New Jersey for the year 1873. 8vo, pp. 32. Trenton, 1873.

On the Structure and Affinities of the Brontotheridæ. By O. C. Marsh. 8vo, pp. 6. 2 plates. (From Am. Jour. Sci. and Arts, Vol. vii, Jan. 1874). Rec'd Jan. 5, 1874.

Note Additionelle au Memoire de M. W.-T. Brigham, intitulé, Volcanic Manifestations in New England. By Albert Lancaster. (Memoirs Boston Soc. Nat. Hist., Vol. ii, Part ii, No. iv) 4to, pp. 7. Boston, 1873.

Embryology of Terebratulina. By Edward S. Morse. (Memoirs Boston Soc. Nat. Hist., Vol. ii, Part iii, No. i). 4to, pp. 16. 2 plates. Boston, 1873.

Explorations of 1872: U. S. Geological Survey of the Territories under F. W. Hayden; Snake River Division. 8vo, pp. 14. (From Am. Jour. Sci. and Arts, Vol. vi, Sept., 1873.)

Twenty-first Annual Report of the Trustees of the Peabody Institute of Peabody. 8vo, pp. 23. Peabody, 1873.

Louis Agassiz as a Teacher of Science. (Remarks of Prof. D. C. Gilman, at the Memorial Meeting of the California Academy of Sciences, Dec. 22, 1873). 8vo, pp. 8.

The Origin and Propagation of Disease. (Anniversary Discourse delivered before the N. Y. Academy of Medicine, Nov. 20, 1873. By John C. Dalton. Appleton & Co., New York, 1874.

Manual of Physical Geography and Institutions of the State of Iowa. By C. A. White. Small 4to, pp. 85. 3 maps and several woodcuts. Day, Egbert & Fidlar, Davenport, 1873.

Anwendung der Darwinschen Lehre auf Bienen. By Hermann Muller. 8vo, pp. 92. 2 plates. Bonn.

Seltsame Geschichte eines Tagfalters. Von Samuel H. Scudder. 8vo, pp. 8.

The Birds of North America drawn from life and uniformly reduced to one-quarter their natural size. By Theo. Jasper. Large 4to. Pt. 5. Jacob H. Studer, Publisher, Columbus, Ohio.

Jahrbuch der Kaiserlich-königlichen geologischen Reichsanstalt. 4to. Band xxiii, No. 2. Wien, 1873. Verhandlungen, 1873. Nos 7-10.

Bulletin Mensuel de la Société d'Acclimatation. 8vo, tome x. June-Sept. Paris, 1873.

Tenth Annual Report of the Belfast Naturalists' Field Club. 1872-73. 8vo. Belfast, 1873.

Extraits de Géologie. Par MM. Delesse et de Lapparent. 8vo, pp. 165.

Untersuchungen über die Pseudomorphosen. By Herr Delesse. 8vo, pp. 10. (Abdruck a. d. Zeitschr. d. deutschen geologischen Gesellschaft Jahrg., 1860.

Rapport sur un Memoire de M. Delesse, intitule "Etude des deformations subies par les terrains de la France." 4to, pp. 3. (Extrait des Comptes rendus des seances de l'Academie des Sciences, t. lxxiv, seances du 24 Juin, 1872.

Bulletin of the U. S. Geological and Geographical Survey of the Territories, I. pp. 28. Jan., 1874.

Catalogue of the Phalænidæ of California, II. By A. S. Packard, Jr. From Proceedings Boston Soc. Nat. Hist. 8vo, pp. 27. Published Jan., 1874.

THE

AMERICAN NATURALIST.

Vol. VIII.—MARCH, 1874.—No. 3.

* * *

THREE DIFFERENT MODES OF TEETHING AMONG SELACHIANS.*

BY PROFESSOR LOUIS AGASSIZ.

About two years ago Mr. Orestes St. John came to the Museum of Comparative Zoology with a very large collection of fossil fish teeth, with the intention of identifying them and comparing them with those which we had in our own collections. This became an occasion for me to look over the materials we possess. In former years I had paid considerable attention to the subject and contributed somewhat to the advancement of our knowledge in respect to the peculiarities of teeth among the representatives of the class of Selachians. I soon found that the progress of paleontology and zoology made the present materials on hand quite insufficient for the task. It was not known how constant the characters derived from the teeth among Selachians could be considered to be, or, with few exceptions, what changes took place with age. So I determined upon the voyage of the Hassler

---

*This paper is printed from a report taken of Professor Agassiz' communication before the "National Academy of Sciences" at its meeting in Cambridge, Nov. 20, 1872. It was the intention of the author to revise the report for publication in the NATURALIST, and he had begun to do so, the first four pages of the manuscript having been corrected during the last two weeks that he was at his museum. The paper can therefore be considered in part as one of the latest efforts of the lamented author, and it must be remembered that he would undoubtedly have made many additions and some changes, had not his fatal sickness taken him from the very midst of his active labors. — Eds.

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

to make the collecting of Selachians a principal object of my attention, and to gather specimens in greater number than is usually the case with animals of these large dimensions. I have been richly rewarded for my efforts though it has been at the cost of considerable labor. We now possess in the Museum many thousand specimens of Selachians. I do not suppose there is another collection covering so largely the different stages of growth of these animals. I have examined these specimens one by one and since my return have made a very careful examination of one species in several families, in order to have standards of comparison based upon the study of several hundred specimens for each family.

The result of this examination shows that while in their adult condition the Selachians present characters which are very constant among specimens of the same age, such marked changes take place among them during their growth that even genera have been founded on the difference of age. I wish to show first, that among the adults we have constancy of character. As an example I may take a species of Odontaspis of which I have twenty-five adult specimens. I have selected this genus for special study on account of its relations to the fossil species of the tertiary formation. In Odontaspis the front teeth are placed as if there were a set of front teeth distinct from the canine teeth, and back of them molar teeth of a very different size, all the specimens exhibiting the same arrangement and even the same number of teeth. This is generally the case with the sharks proper. But when we compare specimens of different ages we find in that respect a great deal of difference. There are some species in which at an early age the adult condition is already established, and where the changes are only in the size of the teeth. There are other genera, on the contrary, in which the young have fewer rows, and rows of different kinds of teeth from those which are developed at a later day. As to the manner in which the changes take place I have noticed three essentially different modes of teething.

One is the ordinary mode of development of the teeth among sharks, in which there is a row of teeth standing erect along the outer margin of the jaws, and behind them as many rows of teeth reclining backwards as there are erect teeth outside. These reclining teeth are in various stages of growth; so that to the erect teeth functionally used in catching the prey there correspond three, four, five, six or seven immature teeth placed one behind the other in the fold of the gum, the youngest occupying the innermost portion. These teeth come into play one after another as the front teeth drop off. This is the mode of teething among Selachians with which all zoologists are familiar, as it occurs among sharks generally and among our common skates. The jaw of our large barn-door skate, *Raja ocellata*, for instance, exhibits vertical rows of teeth placed one behind the other, as in the sharks, the innermost of which are immature, while those along the outer edge of the jaw are ready to drop. Some of these teeth may be so slightly attached to the gum that they drop readily, while others are so connected with the jaw that they serve their purpose for a longer time. Now in Selachians which have this mode of teething the teeth begin to show themselves rather late in life. The embryos of these sharks and skates do not have teeth, and even after birth the young show very imperfect or rudimentary teeth. In some of them, after being for some time in the water and providing for their own food, the teeth are so imperfectly developed that no row is visible along the edge of the jaw; but when the teeth rise to the margin of the jaw their number is already fixed and the young teeth are formed in rows behind those of the outer series. From that time no other change takes place except that larger and larger teeth are formed behind the old ones as these drop in succession; and as the old ones drop the next oldest come into play and so on.

In Galeocerdo, a genus of much interest to paleontologists, the teeth are very uniform in both jaws and more nearly of the same size than in other families, while the teeth which are to replace the old ones are not much larger, thus showing that these sharks grow very slowly. These facts are very important with reference to the identification of the fossil species. In younger specimens of this genus there are fewer rows of replacement teeth and they resemble adult teeth much less than they do here. As the jaw enlarges with age, the new sets of teeth enlarge also, and in that manner the whole margin is always occupied by teeth.

In Cestracion, on the contrary (and under this name I designate the Port Jackson shark and not the hammer-heads), we have a totally different mode of teething, the knowledge of which is essential to a correct appreciation of the zoological value of a vast number of fossil teeth characteristic of the older and middle geological formations. I have been fortunate enough to secure a large number of specimens of the Cestracion living along the coasts of California, Peru and the Galapagos Islands. I have those of Australia also in various stages of growth, so that I could ascertain the mode of dentition of the genus by a comparison of different species. In the adult, as is well known, the front teeth are pointed, while the lateral teeth are grinders, and there are grinders with flat surfaces and grinders of different forms, in the middle of the jaw and behind. What is particularly characteristic of these fishes is that the teeth rest upon the surface of the jaw, forming flat expanses for chewing, and that many teeth are at work at the same time; also that the inner part only of the rows is in progress of formation, while a great many rows act at the same time.

In this condition, the genus Cestracion has been described, and it is generally understood that what distinguishes it is the presence of these different kinds of teeth; but when I had an opportunity to examine the younger ones, I found that there were none of those peculiar teeth in the back part of the jaw. Young that swim about in search of prey exhibit only the conical teeth at the anterior part of the jaw and have none of the teeth with flat surfaces at the hinder part of the jaw. What is still more striking is that these front teeth, corresponding to the front teeth of the adult, have not single points as in the adult but two lateral prongs. The teeth which are behind are gradually reduced to three prongs, and finally only one prong with a little hook on the side, and in very old specimens even these little prongs at the side are wanting; so that you have a succession of different teeth resulting from the gradual change in the teeth of the same series. The first teeth of the young have this complicated character which is maintained through successive droppings before the teeth of another character come in. These remain for a time again until a third type of teeth is brought in. As these changes go on in the front we find that row after row is added behind, so that the number of rows covering the surface of the jaw is gradually increased.

We see in this a different arrangement from the other sharks, in which the total number of teeth in the jaw is early established and remains the same for life, while here the number of rows increases and the rows forming behind have a totally different character from those in front. The front teeth in these rows constantly drop and give place to others. This implies a functional differentiation which is marvellous. Mark that every tooth that replaces another has a different character from the previous one. We have here opportunities for variation, for changes, for transmutation, to an extent which has not been noticed in any other family of animals as far as I know.

Let me here say that from single specimens of Cestracions, obtained in different parts of the world, have been indicated three supposed genera based on the conditions of the teeth at different periods of age.

To show that this should not be accepted as an unquestionable result, let me say that I have examined the young of the three supposed genera. They are all provided with keeled molar teeth, while the adults have the flat grinders supposed to be characteristic of the Cestracion type alone. I am therefore satisfied that it is worth while to collect largely and preserve a number of specimens, even if they be sharks and skates and occupy a great deal of room, in order to learn their history, which has shown of just what importance has been the identification of teeth among fossils. Thus sharks drop their teeth and scatter them along the bed of the ocean in great numbers, probably ten or twenty times as many as they have at one time while living, so that it is not to be wondered at that we so frequently find in collections of fossils loose teeth of sharks, and that we so rarely find the jaws of sharks with teeth in their places.

Of course in those species in which the teeth are isolated and do not support one another, we should hardly ever expect to find them fossil in position; while those which are pressed upon one another may be found in the fossil state, and that occurs again and again, and among the fossil fishes there are a number of sharks in which jaws with teeth arranged in rows are represented.

There is a third mode of teething as different from the other two as these two are different from one another. It occurs in the family of Myliobatidæ among the skates. In Myliobatis, as generally known in the mature condition, we have a middle row of broad and short teeth; along the margin are a number of rows of smaller teeth, and it is known that in front these teeth drop and are replaced from behind. For a long time I could not understand how teeth of a large size could follow the teeth of very small dimensions which exist in the young. In the teeth of the young taken from the mother, embryos therefore, and not young in the ordinary sense, the whole width of the dentary portion of the jaw is not half the width of the central tooth of an adult, but on careful examination it will be seen that the hind part of these teeth is not as broad as the front part. They form in fact cones, and of course a cone long enough will bring to the front part very small teeth. Teeth as small as a pin's head are actually found in the jaw. I have examined a number of jaws of Myliobatis, all of which show that fifty times as many teeth must have been dropped as remain in the jaw. The teeth are not pushed sidewise: they are pushed forward. This occurs in Myliobatis, where we have a number of teeth varying from a single one in the centre of the jaw, to four rows on each side and a middle row in addition, all of which progress from behind forward. In the genus Ætobatis the teeth are conical, the front part being much narrower than the hind part.

The introduction of the new kind of teeth is a complicated thing to explain, and to state the changes which they undergo by age would occupy too much time. Let me say only, that besides these principal modes of teething we have some modifications of them which are characteristic of particular families. In the ordinary skates (Raja) the rows of teeth are disconnected from one another and run from the margin inward in unbroken continuity. In the sting-rays (Trygon) and all the representatives of that family, they cover the jaw closely and are quincuncially arranged. That is, while in the common skates the rows are nearly straight, in the sting-rays there are border rows and between them other rows, so that the whole surface of the jaw is covered with teeth. It is as if the teeth of the common skate had been brought together and crowded, so that one row was pressed into the space of another; the teeth do not drop singly but are brought forward like a pavement, the margin of which is gradually dropping.

There is another modification characteristic of the dog-fish (Acanthias) in which the teeth of the successive rows overlap one another from the side; not uniformly from both sides but from one side; so that one tooth overlaps the other tooth, and so on, as if they had been squeezed from the side and made to pass over the next tooth in that way.

If from the living sharks we pass to the fossils, we have still other modes of teething. We find in some of them instead of distinct teeth plates covering the jaw, only three plates on each half of each jaw. These plates are conical; that is, pointed along the margin and broader inward. The teeth increase by curving the point over the jaw while the inner margin is gradually enlarging. The triangular pointing of the teeth accounts for the increased dimensions of the teeth from the young to the adult.

We have one further step where the teeth, instead of being only laid down on the surface of the jaw, are actually incorporated with it, so soldered with it that between the jaw and teeth there is hardly any difference recognizable.

THE WILD CATTLE OF SCOTLAND, OR WHITE FOREST BREED.

BY E. LEWIS STURTEVANT.

According to our best authorities two forms of the ox tribe, the genus Bos, existed in Scotland at an early period, *Bos primigenius* and *B. longifrons* of Owen. The former was of large size, and according to all accounts the color was black; it had white horns with long black points, the hide was covered with hair shorter and smoother than in the tame ox, but on the forehead long and curly. From the skeletons preserved in our museums the length of this gigantic ox must have been from eleven and one-half to twelve feet, and the height at the shoulders about six or six and one-half feet.[*] Darwin remarks that the Pembroke race in England closely resembles this ox in essential structure, and that the cattle at present existing in the Chillingham Park are degenerate descendants of this breed.[†] *Bos longifrons*, on the contrary, is described as a distinct species, of small size, short body and fine legs. It was domesticated in England during the Roman period.[‡] Professor Owen thinks it probable that the Welsh and Highland cattle were descended from this species.[§]

---

[*] Nilsson, Annals and Mag. of Nat. Hist., 1849, iv, 258.

[†] Animals and Plants under Domestication, i, 103.

[‡] British Pleistocene Mammalia, p. xv.

[§] Animals and Plants under Dom., i, 104.

A continuous range of enormous forests covered the whole extent of the country in prehistoric times, while the gigantic and fierce cattle roamed through the chase,[*] and fed on the tender branches and buds, the catkins of birch, hazel, sallow, and other species of willow,[†] resembling in this matter of feeding the moose of the Canadian forests. We have reason to suppose that the ancient islanders introduced the rudiments of a pastoral life, while yet living in pits incovered with boughs and skins,[‡] yet no evidence leads to the conclusion that the native Britons had domesticated the great oxen of the country, although undoubtedly they formed a source of food.[§] In Switzerland, on the contrary, the lake dwellers had succeeded in taming these formidable brutes.[‖]

We have it stated by Darwin, that *Bos primigenius* existed as a wild animal in Cæsar's time.[¶] There is a record of white cattle in the tenth century, resembling those in the Scottish parks, existing in Wales, where they were more valued than black cattle.[**] Boethius, in 1526, mentions them as then existing near Stirling. "At this toun began the grit wod of Calidon. This wod of Calidon ran fra Striveling throw Menteith and Stratherne to Atholl and Lochquabir, as Ptolome writtis in his first table. In this wod wes sum time quhit bullis, with crisp and curland mane, like feirs lionis, and thoucht thay semit meek and tame in the remanent figure of thair bodyis, thay wer mair wild than ony uthir beistis, and had sic hatrent aganis the societe and cumpany of men that thay come nevir in the wodis, nor lesuris quhair thay fand ony feit or haind thairof, any mony dayis eftir, thay eit nocht of the herbis that wer twichit or handillit be men. Thir bullis wer sa wild, that thay wer nevir tane but slight and crafty laubour, and sa impacient that eftir thair taking they deit for importable doloure. Alse sone as ony man invadit thir bullis, they ruschit with so terrible preis on him, that they dang him to the eird, takand na feir of houndis, scharp lancis, nor uthir maist penetrive wapinnis." "And thoucht thir bullis were bred in sindry boundis of the Calidon wod, now, be continwal hunting and lust of insolent men, thay are distroyit in all partis of Scotland, and nane of thaim left bot allanerlie in

---

[*] Prehistoric Scotland. Wilson's. [†] Nilsson. An. & Mag. of Nat. Hist., 1849, iv, 269.

[‡] Prehistoric Scotland, i, 296. [§] Prehistoric Scotland, i, 31.

[‖] Lyell's Antiq. of Man. Phila., 1863. p. 24.

[¶] Animals and Plants under Domestication, i, 104. [**] Low's Animals, 239.

Cumarnauld."* In a remarkable document, written about 1570, the writer complains of the aggressions of the King's party in the destruction of the deer in the forest of Cumbernauld, "and the quhit ky and bullis of the said forest, to the gryt destructione of policie and hinder of the commonweill. For that kynd of ky and bullis he bein kepit thir money zeiris in the said forest, and the like was not mantenit in ony vther partis of the Ile of Albion."† In 1598, John Leslie, Bishop of Ross, speaks of the wild ox occurring in the woods of Scotland, of a white color, with a thick mane, resembling a lion's, and wild and savage. He says that it had formerly abounded in the Sylva Caledonia, but was then only to be found at Stirling, Cumbernauld, and Kincardine.‡ Sandford, in his manuscript history of Cumberland, dated 1675, says around Naworth formerly were "pleasant woods and gardens; ground full of fallow dear, fieding on all somer-tyme; brawe venison pasties, and great store of reid dear on the mountains; and white wild cattle, with black ears, only on the moores."§ We find them referred to by Bewick in 1770, and in 1781 Pennant speaks of them as retaining their white color, but as having lost their manes.‖ Conrad Gesner describes them as "white oxen, maned about the neck like a lion. . . . . This beast is so hateful and fearful of mankind, that it will not feed of that grasse or those hearbes whereof he savoureth a man hath touched—no, not for many days together; and if, by art or policy, they happen to be taken alive, they will die with very sudden grief. If they meet a man, presently they make force at him, fearing neither dogs, spears, nor other weapons." (16th century; quoted from Scherer's Rural Life, p. 627.)

"Here (Cadzow Castle), so late as the year 1760, were a few of those white cattle with black or brown ears and muzzles, once so common in Scotland. Their shyness and ferocity of temper rendered them troublesome and of little use, they were therefore exterminated in the year above mentioned." (The History of the City of Glasgow, etc., by James Denholm Glasgow, 1798, p. 252.)

---

* Hector Bosce, born in 1470. Hist. Scotorum, pub. at Paris, 1526, ed. of 1574, fol. 6, line 68, occurs the passage quoted in An. & Mag. of Nat. Hist., 1839, ii, 281, and Low's Animals, 234.

† Illustrations of Scottish History, preserved from manuscripts by Sir John Graham Dalyell, Bart., quoted in Low's Animals, p. 235.

‡ Leslie. De Origine Moribus et Rebus Gestis Scotorum. Rome, 1598, ed. of 1675, 18, quoted in An. & Mag. of Nat. Hist., 1839, ii, 282. Also in Low's Animals, 234.

§ Jour. R. A. S., 1852, xiii, 249. ‖ Quadrupeds, 16.

About 1800 they are spoken of as invariably white, with the ears internally, and externally about one-third down, red; horns white, tipped with black, and the muzzles black.[*] In 1836, we begin to get more particular descriptions. Color invariably white, muzzle black, the whole of the inside of the ear, and about one-third of the outside, from the tip downward, red. The horns are very fine, white with black tips; and the head and legs are slender and elegant.[†] The Earl of Tankerville, the proprietor of Chillingham park, describes them in 1839. In form they are beautifully shaped, with short legs, straight back, horns of a very fine texture, as also their skin so that some of the bulls appear of a cream color.[‡] In 1845, Low says that the eyelashes and tips of the horns are black, the muzzle brown, the inside and a portion of the external parts of the ears are reddish-brown, and all the rest of the animal white. The bulls have merely the rudiments of manes, consisting of a ridge of coarse hair upon the neck.[§] In 1852, William Dickinson says that their bodies are pale cream color, the ear tips red and the muzzle black.[‖] In 1868, Darwin describes them as white with the inside of the ears reddish-brown, eyes rimmed with black, muzzle brown, hoofs black, and horns white tipped with black.[¶] Youatt mentions the existence of a mane on some of the bulls, one and one-half or two inches in length.[**]

As a wild race we hear of their occurrence at rare intervals. In the time of Edward the Confessor (1042), we are told by one of the abbots of St. Albans that wild bulls abounded near London,[††] and Fitz-Stephen writing about 1174, speaks likewise of their occurrence in these woods.[‡‡] In 1760, wild white cattle were just extinct in the central Highlands.[§§] In 1598, their occurrence in Scotland was confined to but a few localities.[‖‖] We are thus particular in tracing the accounts of this breed, as Wilson maintains that no sufficient evidence has ever been brought forward to prove that these cattle are entitled to the character of an aboriginal breed.[¶¶] Of the remnants of this ancient race, we have two herds, at least, existing at the present time, and records of others whose extinction has been comparatively recent. The general descriptions of white with colored ears apply to all, yet each herd has had its distinctive features, and we find evidence of a constant tendency to variation, only repressed by a rigorous selection.

---

[*] Complete Grazier, p. i. [†] Naturalists' Lib., Jardine, iv, 202.
[‡] An. & Mag. of Nat. Hist., 1839, ii, 277. [§] Low's Animals, 237.
[‖] Jour. R. A. S., 1852, xiii, 219. [¶] An. & Pl. under Dom., 107.
[**] Youatt & Martin on Cattle, 12. [††] An. & Mag. Nat. Hist., 1st ser., iii, 356.
[‡‡] An. & Mag. Nat. Hist., 1849, iv, 423. [§§] Trans. H. & Ag. Soc., 4th series, v, 294.
[‖‖] Low's Animals, 234. [¶¶] Enc. Brit., xiv, 214.

Chillingham castle, the seat of the Earl of Tankerville, is situated in Northumberland County, England, and formerly occupied one end of the Caledonian forest, which in former times extended from sea to sea. The wild cattle have been preserved in this park with care, and kept free from intermixture with other breeds. They have been extensively inbred from necessity, "and are accordingly much subject to rash, a complaint common to animals bred in and in." We find it recorded that the stock at Chillingham was at one time left without a bull, from accident and sterility. Fortunately one of the cows had a bull calf, and the stock was preserved.[*] In color, they are invariably white[†] or white,[‡] or pale cream color[§] or creamy white.[‖] or white and cream color.[¶] Their horns are white tipped with black; their muzzle black[**] or brown;[††] their eyelashes black;[‡‡] their eyes rimmed with black.[§§] Their ears inwardly and about one-third externally, red,[‖‖] reddish-brown,[¶¶] or red or brown.[***] Their necks have rudimentary manes,[†††] or oftentimes a mane from one and a half to two inches long,[‡‡‡] or no manes but coarse hair.[§§§] Their heads slender,[‖‖‖] backs straight. Legs short[¶¶¶] and slender,[****] and the hoofs black.[††††]

In 1675, as we have seen, they are described with black ears.[‡‡‡‡] In 1770 according to Bewick, some calves appeared with black ears, but these were destroyed, and black ears had not since reappeared.[§§§§] Since 1855 about a dozen calves have been born with brown or blue spots on their cheeks or necks, but these, with any other defective animals, were immediately destroyed,* and Low speaks of the tendency of the young to be altogether black or altogether white, or to have black ears.† In Knox's "Natural History," published probably in the earlier part of the present century, these cattle are said to have lost their manes, but to have retained their color and fierceness; to be of a middle size, long legged, with black muzzles and ears, and their horns to be fine and to have a bold and elegant bend. The keeper of those at Chillingham said that the weight of the ox was thirty-eight stone, of the cow twenty-eight. It would thus seem as if Knox spoke from personal observation (vol. i, p. 55).

---

[*] Earl of Tankerville, Annals and Mag. of Nat. Hist., 1839, ii, 284. Nat. Lib., Jardine, iv, 207, note.

[†] Nat. Lib., Jardine, iv, 202, note.

[‡] Darwin, An. & Pl., under Dom., i, 107.

[§] Hindmarsh, An. & Mag. Nat. Hist., 1839, ii, 279. Dickinson, Jour. R. A. S. of Eng., 1852. 249.

[‖] Capt. Davy, Milk Journal, Oct., 2, 1871, 225.

[¶] Earl of Tankerville, Annals of Nat. Hist., 1839, ii, 277.

[**] Dickinson, Nat. Lib., Capt. Davy, *op. cit.*

[††] Low, Darwin, Earl of Tankerville, *op. cit.*

[‡‡] Low, Hindmarsh, *op. cit.*

[§§] Hindmarsh, Darwin, *op. cit.*

[‖‖] Dickinson, Nat. Lib., *op. cit.*

[¶¶] Low, Darwin, *op. cit.*

[***] Earl of Tankerville, Annals of Nat. Hist., 1839, ii, 277.

[†††] Low's Animals, p. 237.

[‡‡‡] Youatt and Martin on Cattle, p. 12.

[§§§] Earl of Tankerville, An. of Nat. Hist., 1839, ii, 277.

[‖‖‖] Earl of Tankerville, An. of Nat. Hist., 1839, ii, 284.

[¶¶¶] Earl of Tankerville, An. of Nat. Hist., 1839, ii, 277.

[****] Nat. Lib., Jardine, iv, 202, note.

[††††] Darwin, An. & Pl. under Dom., i, 107.

[‡‡‡‡] Jour. R. A. S., 1852, xiii, 249.

[§§§§] Darwin, An. and Pl. under Dom., i, 107.

The Hamilton Park cattle are often referred to as the cattle of the Chase of Cadzow, after the castle of that name, the former seat of the dukes of Hamilton. Cadzow Castle occupies a site on the banks of the Avon in Lanarkshire, at one extremity of the ancient Caledonian wood. Aiton, in 1814, describes these cattle as uniformly of a creamy white color, their muzzles and the greater part of their ears black or brown, and some with a few black spots on their sides. A few are without horns, but the greater number have handsome white ones, with black tips bent like a new moon. Some of the bulls have a sort of mane, four or five inches long. The cattle at Hamilton and Ardrossan are not so fierce and savage as their ancestors, but at Auchencruive they still retain much of their natural ferocity. Their backs are high and not so straight as could be wished. Their chest is deep, but narrow, and they have much the appearance of the ill-fed native breed of the cattle of Ayrshire, Lanarkshire, etc., about fifty years ago.‡ In 1845 Low describes them as with the females generally polled,§ and in 1870 the bulls are credited with black tipped horns.‖ Their color is given as dun white,¶ or dingy white,** their muzzle and hoofs black,†† as also the inside of the ears,†† and the tongue.‡‡ In the "Naturalist's Library" we find it stated that their bodies are thick and short, their limbs stouter than the Chillingham breed, and their heads much rounder, the inside of their mouths either black or spotted with black, and the fore part of their legs, from the knee downward, mottled with black.§§ At one time but thirteen remained alive, the survivors of the cattle plague of the few years previous. The bulls looked as if they might fatten to eight hundred or eight hundred and fifty pounds. They had light hind quarters but were heavy and deep in front; all had black muzzles, black ears, and the older beasts black tips to their horns.[*] We were told that some years ago the herd numbered eighty or ninety, but all fell victims to the cattle plague, except thirteen, of which eleven altogether escaped and two recovered. When the plague attacked them, they were driven individually between gradually approaching fences, leading to a large and strong wagon sunk to the ground level, and so captured, and taken to separate abodes, where they were confined until all risk was passed. They have now (in 1870) increased to thirty-seven.[†]

---

* Darwin, An. and Pl. under Dom., i, 107. † Low's Animals, 238.

‡ Sinclair's Scotland, iii, 41. § Low's Animals, 236.

‖ Gard. Chron. and Ag. Gaz., Aug. 6, 1870. ¶ Low, Nat. Lib., *op. cit.*

** Dickinson, Jour. R. A. S., of Eng., 1852, 249. †† Low, Nat. Lib., *op. cit.*

‡‡ Low's Animals, 236. §§ Nat. Lib., Jardine, iv, 202, note.

We have mention of some having been kept at Ardrossan and Auchencruive, but no further particulars, except that those at the latter place were very fierce.[‡] They were also kept at Bishop-Auckland in 1685.[§]

The cattle preserved at Drumlanrig, the seat of the Duke of Queensberry, are said by Darwin to have become extinct in 1780, and are described as with their ears, muzzle and orbits of the eyes black.[‖] Pennant writing in 1781 speaks of them as still existing, having lost their manes, but of a white color.[¶] Dickinson states that two cows and a bull were living in 1821, but the bull and one of the cows died that year. He describes them as dun or rather flea-bitten white, polled, with black muzzles and ear tips, with spotted legs.[**] Low says they were destroyed many years ago by order of the late Duke of Queensberry.

The cattle at Gisburne Park, in Craven, County of Yorkshire, England, the seat of Lord Ribbesdale, are mentioned, as late as 1852, as being pure white with brown or red ears and noses.[††] Low speaks of their being polled,[‡‡] and Bewick describes them as perfectly white except the inside of their ears which are brown. They are without horns, very strong boned but not high.[§§] He also states, as Darwin quotes, that they are sometimes without dark muzzles.[*] They are said to have been originally brought from Whalley Abbey, in Lancashire, upon its dissolution in 1542.[†]

---

[*] Gard. Chron. and Ag. Gaz., Aug. 6, 1870. [†] Gard. Chron. and Ag. Gaz., Aug. 6, 1870.

[‡] Sinclair's Scotland, iii, 44. [§] An. Nat. Hist., vol. iii, ser. 1, p. 241.

[‖] Darwin, An. and Pl. under. Dom., i, 107. [¶] Quadrupeds, 16.

[**] Dickinson, Jour. R. A. S. of Eng., 1852, 249.

[††] Dickinson, Jour. R. A. S., 1852, 249.

[‡‡] Low's Animals, 238.

[§§] Bewick's Quadrupeds, 8th edit., 39, note.

The herd at Burton Constable, also in Yorkshire, situated in the district of Holderness, all perished in the middle of the last century of an epidemic disorder. They were of large size, and had the ears, muzzle and tip of the tail, black.[‡]

At Chartley Park, in Staffordshire, England, the property of Lord Ferrers, Low states that a herd exists, resembling those at Chillingham, but of larger size, and having the muzzles and ears black. He also adds that they frequently tend to become entirely black. This herd is very ancient, having existed in this park from time immemorial.[§]

Wild cattle, says Low, have been or are yet preserved at Wollaton in Nottinghamshire and at Limehall in Cheshire, England,[‖] and Bewick states that the ears and nose of all of them are black.[¶]

These cattle, in the possession of ancestral families, and maintained and protected in parks, undoubtedly as a family pride, have with difficulty been preserved through the epidemics and casualties of a few centuries. Yet, despite the human care and the rigorous weeding out of blemishes, we can see they were unable to retain in their color or form much more than a resemblance. In the Chillingham cattle the muzzle is described as black or brown, the ears inwardly, and in part externally, red, reddish-brown and red or brown. Their manes either short, or rudimentary, or not existing. We find black ears and blemishes occurring at different times. In the Hamilton herd we find them generally with horns at an early date, but afterwards the females usually polled. Black spots on sides and legs are noticed. They are described as possessing manes of from four to five inches long, especially some bulls. Their limbs have become stouter and their heads shorter than the Chillingham breed at the other end of the ancient wood. Those at Drumlanrig have become polled, presumably in both sexes. At Gisburne Park, they are not only hornless, but only the inside of their ears are colored, and occasionally they lose their dark muzzle. At Burton Constable, among their fertile pastures, we see an increase of size, the effect of the abundance of the feed, and the ends of the tail have become black. In Staffordshire, we observe the tendency to become entirely black.

---

[*] An. and Pl. under Dom., i. 108. [†] Bewick's Quadrupeds, 8th edit., p. 39, note.
[‡] Low's Animals, 238. [§] Low's Animals, 238. [‖] Low's Animals, 238.
[¶] Bewick's Quadrupeds, 8th edit., 39, note.

When even selection finds it so difficult to preserve the uniformity of the same herd for successive years, and fails even more glaringly when applied to different herds under varied circumstances, we can hardly be justified in rejecting these white cattle as the primitive or foundation stock of existing breeds of that county on account of their color alone.

The wild state seems peculiarly favorable to uniformity of coloring, as the causes which have operated to produce the result on a few act likewise upon all, and are constant in their action. Any deviations from the markings appear to become absorbed in the multitude, so as to have little opportunity for preservation. In civilization, on the contrary, we have the element of human will, a highly complex and variable possession, which interrupts the apparent harmony of uncultured nature, by rendering new combinations possible and probable. That a slight interference with a natural state will produce variability of coloring is well shown in an account of the cattle of Paraguay by Azara, wherein it is stated that the wild cattle are always a reddish pard color, and thus differ in color from the domesticated breeds.* When it is considered how little tameness is called domestication in these regions, it is realized upon what obscure causes the fact of color must depend. Even in our most ancient breeds we find variations of color, as in the Highland, Galloway and Devon.† The strongest single argument in favor of these white cattle being the forefathers of our present stock, is in the occasional cases of reversion, which occur in many of the breeds, and oftener in those whose connection with the wild breed seems probable. In the West Highland breed, usually black, the white color and the ear markings in many cases return.‡ In the Ayrshire cow I have record of two cases of reversion to white with red ears, and I can remark, after a most careful examination of Ayrshire cows, that I have never seen white ears, or ears the tips of which were other than red, brown or black. In shape we have the differences inherent to locality. Mountain breeds are apt to be lighter in their hindquarters than breeds occupying a plain, as we are told by Low,§ and it is obvious to any observer that semi-domesticated breeds are lighter in the flanks and loins, than those breeds which have been subjected to systematic breeding. In the Ayrshire breed we find the medium horn, often the direction of the curve and the frequent black tip pointing to the wild breed, as also the white face, or starred forehead, and the "rigged" back occasionally or frequently recurring, to direct our attention to the transition cattle between the original stock, and the recorded results of breeding, coeval with the advanced interest in agricultural pursuits at or about 1800.

---

* Nat. Hist. of the Quadrupeds of Paraguay, Edinb., 1838, 73.

† Low, *passim*. ‡ Low's Animals, 301. § Low's Animals, 305.

These cattle in their present state are easily and readily tamed and crosses with common stock are occasionally noted. Such with the forest bull are said by Bewick to invariably take the color of the father and to retain some of the fierceness.[*] The recorded instance of the crossing of a cow of the white breed by a common bull gives the color of the progeny as after the forest pattern, but with mottled legs.[†]

When we consider the small number of these cattle, and the length of time they have been preserved, and how narrowly they have escaped utter extinction, it is difficult to suppose that they have been retained in their purity; still less when we consider the disturbances of the times, the number of cattle grazing continually in their vicinity, and the striking resemblance which is often shown to them by cattle of other breeds. According to Low, individuals were to be met with in 1845, in the county of Pembroke, in no ways distinguishable from the wild cattle of the Parks,[‡] and Aiton speaks of their resemblance to the common cattle of 1750. I have myself seen in America, cattle which were pure white with red ears, and even polled.

The only explanation which I can see for the variations between the herds of forest cattle and the tendency towards variation, which seems from our account to have been ever strong, is that these, as well as the domestic cattle of those regions, are offshoots from the same original stock, the wild ox of the past, but that those races we call domesticated, as the Ayrshire, the Angus, the Galloway, the Highland and others, have been influenced to a greater extent by the arts of civilization, the conscious or unconscious breeding for certain uses, and the effects of crossing, than these inhabitants of the parks.

On this view the White Forest Breed is a wild animal, a descend-ant, with now and then a bar sinister, of the wild breed, and the domesticated races of the country are likewise their descendants, but with an ancestry hopelessly confused and intermixed by outside crosses and influences.

---

[*] Bewick's Quadrupeds, 41, note.

[†] Hindmarsh, Ann. and Mag. of Nat. Hist., 1839, ii, 280.

[‡] Animals, 296.

EXPLORATION OF THE GULF OF MAINE WITH THE DREDGE.

BY A. S. PACKARD, JR.*

Though it was the original intention to devote the month to an exploration of George's Bank, it was decided on account of the "Bache's" defective boilers to work nearer shore and extend farther from land the work of the U. S. Fish Commission, for the season located in Casco Bay; the dredging operations being conducted under the charge of Professor Verrill. This involved an examination of certain unexplored portions of that great indentation lying between Cape Sable, Nova Scotia, and Cape Cod, and which is laid down on the charts as the "Gulf of Maine."

Through the researches of Messrs. Stimpson, Verrill, myself and others in the Bay of Fundy, and of Drs. Gould, Wheatland, Stimpson and others in Massachusetts Bay, together with the very thorough examination of Casco Bay and vicinity pursued during the past summer by Professors Baird and Verrill, we had attained a very complete knowledge of the coast fauna of New England north of Cape Cod. Moreover, the explorations of George's Bank made by Messrs. Smith, Harger and myself last year in the "Bache," had given us some idea of the nature of the sea bottom there, dredging having been carried on at a depth of four hundred and thirty-two fathoms by Messrs. Smith and Harger, and in one hundred and fifty fathoms by myself.

---

*Report of Explorations with the Dredge on the U. S. Coast Survey Steamer "Bache," in the Gulf of Maine, during September, 1873, under the direction of Prof. Baird, U. S. Fish Commissioner, made to the Superintendent of the Coast Survey and to the U. S. Commissioner of Fisheries. In all the work I had the invaluable aid of Mr. C. Cooke, with his great experience in dredging, and owe much to the ready aid and sympathy of Commander Howell, Executive Officer W. H. Jaques, and Lieuts. Hagerman, Jacob, Rush, Bradbury, and Dr. Dickson. Samples of bottom water were taken up at nearly every station, the metal water bottle being used. For the identification of the specimens I am indebted to Professor Verrill.

It now remained to explore some interesting localities within George's Bank, and at a distance from the coast. This report embraces an account of a reconnoissance of Jeffrey's Bank, lying south of Mt. Desert Island; Cashe's Ledge, another bank lying southwest of Jeffrey's Bank; of Jeffrey's Ledge, a northeastern submarine prolongation of Cape Ann; and Stellwagen's Bank, a northerly extension of Cape Cod. As intermediate points were investigated, the series of dredgings may be regarded as conducted along six main lines, running out easterly from the shore between Portland and Cape Cod.

On the 2d of September, the "Bache," with Lieut. Jaques temporarily in command, left Peak's Island, Casco Bay, the headquarters of Professor Baird and his associates, and made a harbor for the night at Boothbay. Early the next morning we ran out and dredged about "Monhegan Falls," in sixty fathoms, searching with dredge, tangle and trawl for the arctic coral (*Primnoa lepadifera*), a species of sea fan which grows about three feet in height. It is occasionally met with in the fiords of Norway at a depth of three hundred fathoms, while fishermen have been said to find it on the ground known as "Monhegan Falls," and a specimen two feet high, from George's Bank, is now in the museum of the Peabody Academy of Science. Our efforts to find it were, however, unavailing.*

We then ran out to Jeffrey's Bank and trawled in eighty-two fathoms, bringing up a fine Comatula (*Antedon Sarsii*), a near ally of the crinoids; this was the first specimen taken by the Fish Commission during the summer. The disk of another specimen was captured on Cashe's Ledge near Jeffrey's Bank. With this also occurred *Nymphon giganteum*, *Calliostoma occidentale*, and *Ophiocnida hispida*. We also dredged in deep brown mud, at a depth of one hundred and seven fathoms, with a temperature of thirty-nine and one-half degrees, several *Hyalonema longissimum* of Sars, hitherto only found on the coast of Norway in from one hundred and twenty to three hundred fathoms. This had previously been found off Casco Bay by Prof. Verrill. Other interesting sponges occurred, and a rare sand-star, *Ophioscolex glacialis*, new to America,[*] and which was dredged by Thompson at a depth of six hundred and forty fathoms near the Færöe Islands. Everywhere on Jeffrey's Bank and Cashe's Ledge the mud was reddish-brown. At noon of September 4th the sea became too rough to dredge, and we ran into a harbor at George's Island, north of Monhegan, for shelter, and on the succeeding day returned to Portland for repairs. On September 12th the "Bache" left Portland for a farther exploration of Jeffrey's Bank, Capt. Howell in command, and on the 13th a series of dredgings were made on each side of the southern extremity of it, at depths of sixty,[†] one hundred and five, and one hundred fathoms (the last point being Station 17. Here the arctic sponge, *Hyalonema longissimum*, occurred), with excellent success. The weather appearing threatening we ran into Portsmouth.

---

* In stations 1, 2, 3, 4 and 5 of my notes, and all from within ten to fifteen miles south of Monhegan Island (station 5 being fifteen miles southeast of Monhegan Island), in from fifty-eight to seventy-two fathoms soft mud, with a bottom temperature of 42° and 43° occurred either at one or another station, though mostly in station 5, seventy-two fathoms, the following:—*Nymphon giganteum.* Crustacea, *Hippolyte spina*, *Ptilocheirus pinguis*, *Byblis Gaimardii*, *Stegocephalus ampulla*, *Anthura brachiata.* Among worms, *Aphrodite aculeata*, *Eunoa Œrstedii*, *Nephthys ingens*, *N. ciliata*, *Ninoe nigripes* Verr., *Nothria conchylega*, *N. opalina* Verr., *Goniada maculata*, *Trophonia aspera*, *Sternaspis fossor*, *Ammotrypane fimbriata*, *Chætozone setosa*, *Nicomache lumbricalis*, *Maldane Sarsii*, *Praxilla gracilis*, *Terebrellides Stroemi*, *Melinna cristata*, *Amage auricula*, *Amphicteis Gunneri*, *Myxicola Steenstrupi*, *Chætoderma nitidulum*, *Priapulus* n. sp., *Phascolosoma cæmentarium* and *Meckelia lurida* Verr. Among the more interesting shells were *Siphonodentalium vitreum*, *Scaphander punctostriata*, *Aporrhais occidentalis*, *Neæra artica*, *N. pellucida*, *Periploma papyracea*, *Astarte lens*, *Yoldia thraciæformis* and *Y. obesa.* Among Tunicates, *Molgula pannosa.* Among Echinoderms, *Psolus phantapus*, *Lophothuria Fabricii*, *Schizaster fragilis* (in seventy-two fathoms only), *Ctenodiscus crispatus*, *Ophioglypha Sarsii*, *O. robusta*, *Ophiocnida hispida*, *Edwardsia farinacea*, *Cerianthus borealis.*

On the 16th we began to dredge on a line extending from Portsmouth to Cashe's Ledge. Stopping to dredge on either side of Jeffrey's Ledge, we found in a mud hole ninety-five to ninety-eight fathoms deep, 14 miles S. E. ¼ E. of Boone Island Light, with a temperature of 37½° and 41°[‡] living *Schizaster fragilis*, a beautiful deep sea urchin; *Molpadia oölitica*, a sea cucumber; *Macoma sabu-*

---

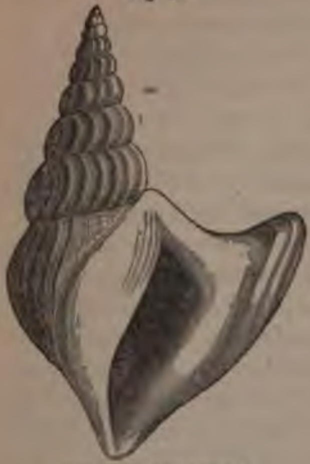
[*] Here also occurred among the worms, *Leanira tetragona*, *Nephthys ingens*, *N. ciliata*, *Ninoë nigripes*, numerous specimens of *Nothria opalina*, *Goniada maculata*, *Scalibregma inflatum*, *Sternaspis fossor*, *Nichomache lumbricalis*, *Maldane Sarsii*, *Praxilla gracilis*, *Terebrellides Stroemii*, *Melinna cristata*, *Amphicteis Gunneri* and *Sabella zonalis*. Also the following shells: *Siphonodentalium vitreum*, *Scaphander punctostriata*, *Periploma papyracea*, *Cryptodon obesus*, *C. Gouldii*, *Yoldia thraciæformis*, *Y. obesa*, the rare *Dacrydium vitreum*; and among Echinoderms, *Schizaster fragilis* and *Ctenodiscus crispatus*.

[†] Station 12, brown mud, with a bottom temperature of 42°; here occurred *Dentalium occidentale*, *Siphonodentalium vitreum*, *Scaphander punctostriata*, *Periploma papyracea*, *Macoma sabulosa*, *Cryptodon obesus*, *C. Gouldii*, *Astarte lens*, *Cyprina islandica*, *Yoldia obesa*, *Dacrydium vitreum* and *Modiolaria corrugata*.

[‡] The readings of both thermometers used are given; the lowest temperature being that given by a new Casella-Miller thermometer from the Smithsonian Institution and probably nearly correct.

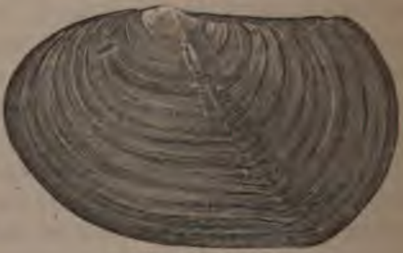
losa and *Aporrhais occidentalis* (Fig. 46), two shells rivalling in size individuals dredged by me in shallow water in Labrador. With these also occurred the remarkable *Cerianthus borealis*, *Yoldia thraciæformis* (Fig. 47; this and 46–52, from Gould's Shells of Mass.) and *Hyalonema longissimum*. This deep valley, so near the shore, afforded the lowest temperature (36½°) found during the month's work.

Fig. 46.



Aporrhais occidentalis.

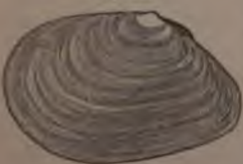
Fig. 47.



Yoldia thraciæformis.

The result of the exploration on Cashe's Ledge was extremely interesting; at depths varying from fifty to eighty fathoms over a hard, gravelly bottom characterized by multitudes of *Ascidia callosa*, or sea potatoes, the richest assemblage of life was found that we met with in the gulf. It was a rare sight to see the tangle come in over the ship's side hung with that gorgeous starfish, the bright red *Hippasteria phrygiana*, measuring fully eight inches across, with lesser forms of *Pteraster militaris*, species of Archaster (*A. arcticus* and *A. Parelii*), Cribella, Asterias, *Antedon Sarsii*, and various sand-stars, a singular barnacle, or Scalpellum (*S. Stroëmi* of Sars), attached to hydroids; an enormous sea spider (*Nymphon giganteum*); *Hyas araneus*, an arctic spider crab, and *Asellodes alta* Stm., with beautiful sponges, such as *Tethya hispida* and

Fig. 48.



Macoma sabulosa.

Thecophora ibla Thompson, dredged by him near the Shetland Islands in from three hundred and forty-four to five hundred and fifty fathoms, and remarkably beautiful spherical forms three or four inches in diameter, these latter appearing in the trawl with Tealia and *Cerianthus borealis* of Verrill, a large sea anemone. The excitement was shared in by the crew, some of whom voluntarily aided in the tedious work of separating them from the strands of the tangle.[*]

On our way back to Gloucester we again dredged on each side of Jeffrey's Ledge at depths of one hundred and twelve and one hundred and eighteen fathoms; at the former station east of the bank dredging the rare hag fish, *Myxine limosa* of Girard (identified by Mr. F. W. Putnam), in soft mud with a bottom temperature in both stations of 39°. On the west side of the Ledge in one hundred and eighteen fathoms occurred *Schizaster fragilis.*

On the 23d dredgings were made in Salem Harbor and off Marblehead. Two days, the 25th and 26th, were devoted to investigating the summit of Jeffrey's Ledge at a distance of nine to ten miles east of Cape Ann.[†]

---

[*] At station 21, beginning with a depth of fifty-two fathoms rocky bottom and drifting off into ninety fathoms gravelly bottom, with sand and some mud, the following species of interest occurred:—*Pycnogonum pelagicum.* Crustacea, *Hyas araneus, H. coarctatus, Lithodes maia, Pandalus annulicornis, Caridion Gordoni, Hippolyte borealis, H. pusiola, Thysanopoda* sp., *Tritropis aculeata, Paramphithoë cataphractus, P. pulchella, Œdiceros lynceus, Unciola irrorata, Asellodes alta* and *Balanus porcatus.* Worms, *Hermione hystrix, Harmothoe imbricata, Euphrosyne borealis, Nereis pelagica, N. fucata, Eunice virida, Nothria conchylega, Ninoë nigripes, Trophonia aspera, Tecturella flaccida, Nichomache lumbricalis, Cistenides granulatus, Terebrellides Stroemii, Thelepus cincinnatus, Amphitrite cirrata, Myxicola Steenstrupi, Sabella zonalis, Potamilla aculifera, Protula media, Filigrana inflexa, Vermilia serrula, Spirorbis lucidus, S. quadrangularis, Phascoloma borealis?, P. cæmentarium, Nemertes affinis, Admete viridula.* Mollusks, *Astyris rosacea, Buccinum undatum, Neptunea decemcostata, Natica clausa, Calliostoma occidentale, Diadora noachina, Polycera* sp., *Scaphander punctostriata, Entalis striolata, E. agilis?, Mya truncata, Macoma sabulosa* (Fig. 48), *Yoldia obesa, Modiolaria corrugata,* and other common shells. Among the Tunicates, *Ascidiopsis complanatus, Cynthia carnea, Ascidia* n. sp., *Amaræcium glabrum, A. pallidum* and *Leptoclinum albidum.* Polyzoa, *Discofascigera lucernaria, Idmonea pruinosa, Tubulipora crates, Hornerea lichenoides, Crisia eburnea, Flustra solida, Discopora Skenei, Cellepora ramulosa, C. scabra, Myriozoum subgracile* and others. Among Echinoderms, *Lophothuria Fabricii, Schizaster fragilis, Asterias vulgaris, Leptasterias tenera, L. compta, Stephanasterias albula, Solaster endeca, Cribrella sanguinolenta, Hippasteria phrygiana, Archaster arcticus, A. Parelii, Pteraster militaris, Ctenodiscus crispatus, Ophiocnida hispida,* and other common Ophiurans, *Antedon Sarsii*; and among other sponges *Thecophora ibla, Polymastia* sp., *Tethya hispida, Isodictya* sp. and *Hyalonema longissimum.*

[†] From stations 27, 28 and 29, from six to fourteen miles east and northeast of Thatcher's Island light, Cape Ann, on top of Jeffrey's Ledge, in from twenty-four to thirty-three fathoms rocky and pebbly bottom, the following more interesting animals

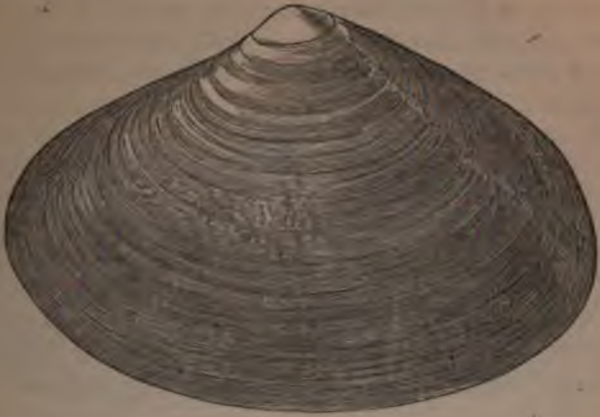
The temperature here was between 46° and 49° in about twenty-five fathoms, a difference of about ten degrees from that of the bottom on each side of this submarine elevation. Both here and afterward we used two dredges, one being thrown over from the bows, the other cast from the stern of the vessel, while the tangle was put over from her side. On the 27th we began to run a line of dredgings and soundings from Cape Ann to Cape Cod, crossing the middle of Stellwagen's Bank. Dredging in depths between fifty and sixty fathoms in soft blue mud northwest of Stellwagen's Bank, in the deepest portions of Massachusetts Bay, the fauna was found to closely resemble similar localities on each side of Jeffrey's Ledge, the assemblage not more southern in character, while the temperature of the bottom water ranged between 41½° and 45° (two thermometers being used as before). In one haul of the tangle ninety-five *Ctenodiscus crispatus*, the common pentagonal starfish of muddy bottoms, were brought up, with several very large *Asterias vulgaris*, and several young *Solaster endeca* and *papposa*. Also a gigantic Corymorpha, a hydroid polype six inches in height and fully half an inch in diameter near the base. It seemed to be a large specimen of *C. pendula*, which we afterwards dredged abundantly on the bank. We found on Stellwagen's Bank, in twenty-two to thirty fathoms coarse sand (temperature 48½° and 50½°), an abundance of *Mactra ovalis* (Fig. 49) the hen clam, *Cyprina Islandica* (Fig. 50) a shell resembling the quahaug, and *Glycimeris siliqua* (Fig. 51), a valve of *Panopæa Norvegica* (Fig. 52), with fine sponges. The Corymorpha was here

---

were taken with dredge and tangle; the more common forms are not mentioned:—*Pycnogonum pelagicum*. Crustacea, *Eupagurus Kroyeri*. *E. pubescens*, *Hippolyte borealis*, *H. polaris*, *H. aculeata*. *H. Fabricii*, *Tritropis aculeata*, *Acanthogone cuspidata* and *Balanus porcatus*. Worms, *Eunoë Œrstedii*, *Cryptonota citrina*. *Nereis pelagica*, *N. fucata*. *Trophonia aspera*. *Thelepus cincinnatus* abundant, *Amphitrite cirrata*, *Myxicola Steenstrupi*. *Sabella zonalis*, *Potamilla aculifera*. *Protula media*. *Vermilia serrula*, *Spirorbis lucidus*, *S. quadrangularis*. Mollusks. *Neptunea curta*, *Aporrhais occidentalis*, *Natica clausa*. *Turritella acicula*, *Margarita Grœnlandica*. etc., *Calliostoma occidentalis*, *Hanleia mendicaria*, *Entalis striolata*, *Panopæa Norvegica*. *Mya truncata*. *Cyclocardia Novangliæ*. *Astarte lens*. *A. undata*. *A. quadrans*, *Nucula delphinodonta*. Tunicates, *Ascidiopsis complanatus*. *Molgula retortiformis*, *Ascidia* n. sp. (the same as in stations 21 and 32. 33. 35). *Amarœcium glabrum*, *A. pallidum*, and *Leptoclinum albidum*. Brachiopoda, *Terebratulina septentrionalis*. Polyzoa, *Discofascigera lucernaria*, *Idmonea pruinosa*, *Flustra solida*, *Cellepora ramulosa* and *C. scabra*. Radiates, *Leptasterias tenera*, *L. compta*, *Stephanasterias albula*. *Pteraster militaris*. *Ophiocnida hispida*. *Halecium muricatum*, *Grammaria abietina*, *Campanularia verticillata*, *Cornulariella modesta*, and *Alcyonium carneum*. Sponges. *Thecophora ibla*, *Polymastia* sp. (the same as at stations 21 and 32–35), *Tethya hispida*, *Trichostemma* sp., *Isodictya* sp. (the same as at stations 21 and 32–35).

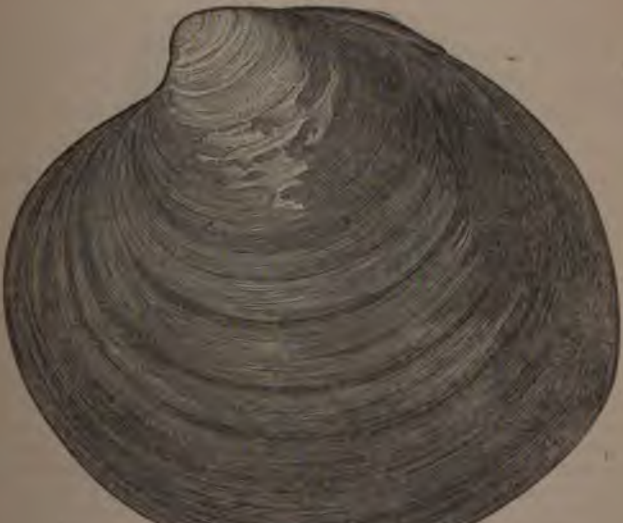
abundant, though much smaller, and the tangle brought up at a single haul from three hundred to four hundred starfish, mostly *Asterias vulgaris*. At night about ten miles north of Cape Race the tangle was kept over from half past ten until two o'clock,

Fig. 49.



Mactra ovalis.

Fig. 50.

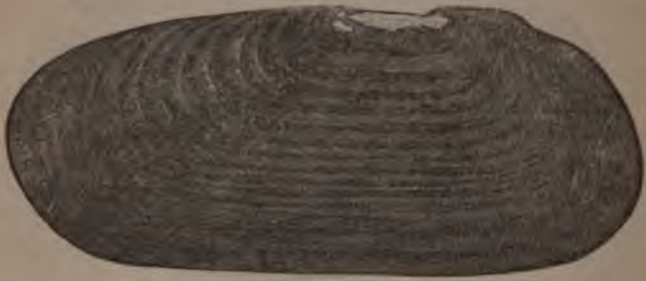


Cyprina Islandica.

when it came up loaded with *Astrophyton Agassizii*, or Medusa's Head, and other kinds of starfish, the temperature being between 48° and 50° at a depth of thirty-four fathoms.*

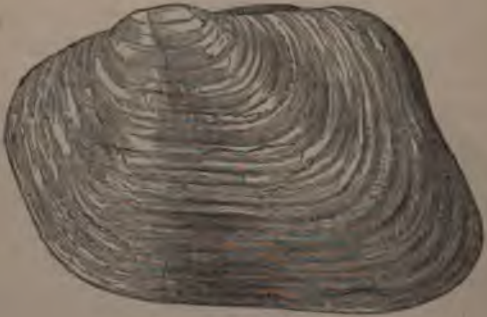
But by far the most interesting results were obtained at a distance of about fifty-five miles due east of Boston in depths of one hundred and seventeen and one hundred and forty-two fathoms, with a bottom temperature of 39° to 43½°; the former (39°) probably the most accurate determination. Here in a remarkably te-

Fig. 51.



Glycimeris siliqua.

Fig. 52.



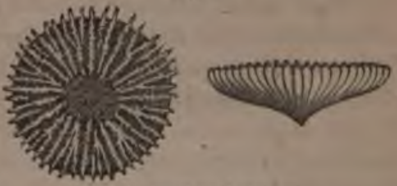
Panopæa Norvegica.

---

* At Stations 32, 33, 34 and 35 upon or near Stellwagen's Bank, though the fauna is very similar to that of Jeffrey's Ledge, the following species occurred, not met with at stations 27-29:—Crustacea, *Hyas araneus*, *Cancer irroratus*, *Eupagurus Bernhardus*, *Hippolyte borealis*, *H. pusiola*, *Paramphithoë cataphractus*, *P. pulchella*, *Moera Danæ*, *Unciola irrorata*, *Phoxus Kroyeri*, *Ptilocheirus pinguis*. Worms, *Nothria opalina*, *Rhynchobolus albus*, *Goniada maculata*, *Nichomache lumbricalis*, *Cistenides granulatus*. Mollusks, *Neptunea decemcostata*, *Aclisa borealis*, *Scalaria Groenlandica*, *Bulbus flavus*, *Turritella erosa*, *Lepeta cæca*, *Scaphander punctostriata*, *Glycimeris siliqua*, *Lyonsia hyalina*, *Pandora trilineata*, *Cyclocardia borealis*, *Pecten tenuicostatus*. The hydroid *Tubularia indivisa*, and a sponge, *Polymastia robusta*?

nacious soft blue mud, we found indications of an intermixture of the abyssal fauna characteristic of depths in the north Atlantic between one hundred and one thousand fathoms, with a temperature of about 39° Fahr. At the first station (36) examined, in one hundred and forty-two fathoms (temperature 39° to 42°) a large *Geryon* of a deep reddish flesh color occurred, having more spines on the carapace than in *G. tridens*, and with eggs. Associated with this arctic crab occurred two fragments of a true cup-coral allied to Caryophyllia. On submitting the specimens to Count Pourtales, he at once pronounced it a species of Deltocyathus, and on comparison with specimens of *D. Agassizii* Pourt. (Fig. 53, after Pourtales), from depths varying from sixty to three hundred and twenty-seven fathoms between Cuba and Florida, our specimens did not differ specifically. Pourtales remarks (p. 15) that "this coral has been pronounced by Dr. Duncan, identical with the fossil species *D. Italicus*, and though closely allied is yet readily distinguished by the costæ and other characters." With the crab and coral occurred *Amphiura Otteri* of Ljungmann, dredged by the Swedish Josephine expedition in five hundred and fifty fathoms off the coast of Portugal; it agrees perfectly, I am told by Prof. Verrill, with the description of that species. It also occurred in the one hundred and seventeen fathom station near by. Such facts as these, the occurrence of an abyssal form of sand-star on opposite sides of the Atlantic, and of the Deltocyathus, seem to favor Lovén's theory of a uniform fauna throughout the bottom of the deeper parts of the Atlantic.* At the same station occurred *Schizaster fragilis* and certain shells, among them *Dacrydium vitreum*, and several worms.† The other station (37) was ten

Fig. 53.



Deltocyathus Agassizii.

---

* I may add that on looking over some gravel dredged in October, 1872, in one hundred and fifty fathoms just northeast of the St. George's Banks, a fragment of another coral occurred, which is entirely new to the coast of North America. It is the *Ulocyathus arcticus* of Sars, as identified by Prof. Verrill.

† The following list comprises all the species found at station 36. Those with * were found at 37 also. Crustacea, **Geryon* sp., *Hyas araneus*, *Scalpellum* sp. Worms, *Nephthys ingens*, *Lumbriconereis fragilis*, *Nothria opalina* V., **Spiochætopterus?* (tubes) **Sternaspis fossor*, *Ammochares* sp., *Maldane Sarsii*, **Arenia* sp. nov., *Terebrellides Stroemii*, *Thelepus cincinnatus*, Mollusks, *Neptunea pygmæa*, **Aporrhais occidentalis*, *Lunatia Grœnlandica*, *Doris* sp.,* *Scaphan-*

miles northwest in one hundred and seventeen fathoms with the same soft tenacious mud; the temperature 36½° to 43½°. Here occurred a smaller Geryon, perhaps a male; and apparently, judging by Wyville Thompson's figure in his work "The Depths of the Sea," p. 881, very closely related to Kroyer's *Geryon tridens;* with this was associated the western Pelican's foot shell, *Aporrhais occidentalis*, and other shells and worms, and a variety of *Ophioglypha affinis* of Lütken, dredged the previous year by Messrs. Smith and Harger at St. George's Bank. This day ended our explorations, and at night the Bache arrived in Salem.

The results of the month's work besides adding quite a number of forms before unknown to exist on our coast, and a few new to science, show that the fauna of the deeper portions of the Gulf of Maine is *almost* purely arctic, the temperature at about one hundred fathoms being from 36½° to 39°. The only apparent exception to this arctic fauna is the presence of a dead broken specimen of the coral Deltocyathus, which however is not improbably a member of the deep sea Atlantic fauna, and may be found living nearer the edge of the Gulf stream in the neighborhood of the St. George's Banks. The fauna of the sandy portions, such as around the southern portion of Stellwagen's Bank, is similar to sandy beaches and adjacent bottoms on the coast of Labrador. As the arctic fauna is best known in northern Norway, so our researches this year have brought to light several forms hitherto only known from Norway, and show that the fauna of that country is identical with that of a region so far south as the area between Cape Sable and Cape Cod, and bounded on the southeast by the Gulf stream. That the waters of the Gulf of Maine do not support a fauna *purely* arctic is shown in the absence of *Rhynconella psittacea*, while *Ophioglypha nodosa* so abundant in shallow bays in Labrador is also wanting. Moreover *Cardium islandicum*, *C. Haysii*, and *Serripes Grœnlandica* do not occur in anything like the abundance and size in which they may be found in shallow water (five to ten fathoms) on the coast of Labrador.

---

der punctostriata, *Dentaliumoccidentale*, **Neæra arctica*, *N. pellucida*, *Macoma sabulosa*, *Cardium pinnulatum*, *Cryptodon obesus*, *Lucina filosa*, *Astarte lens*, **Leda tenuisulcata*, *Yoldia thraciæformis*, *Y. obesa*, *Dacrydium vitreum*. Polyzoa, *Discofascigera lucernaria*, *Cellepora ramulosa*, *Discopora Skenii*, *Hornerea lichenoides*, *Myriozoum subgracile*. Radiates, *Gemellaria loricata*, **Schizaster fragilis*, *Thyone* sp., **Amphiura Otteri*, **Ophioglypha Sarsii*, *O. affinis* (at station 37 only), *Endendrium ramosum* (at 37 only), *Sertularella polyzonias*, *Deltocyathus Agassizii*, **Edwardsia* species.

Finally, the liberality of Professor Pierce, the Superintendent of the Coast Survey, in placing at the service of the Fish Commissioner a fine steamer and every convenience for dredging during an entire month, leads us to indulge the hope that it may in the future seem necessary to the work of the Coast Survey, to make a map of the sea bottom within soundings. The soundings in such case would be better done by the dredge than the lead, as a far better idea of the sea bottom could thus be obtained, than by the slight amount of material usually brought up by the lead, and which is sometimes misleading. A naturalist aboard could sort out the animals and send them to experts for identification. Thus, with slight extra expense, the work already began by M. Pourtales in mapping out the bottom of the Straits of Florida, could be extended, and our north Atlantic sea bottom would be studied and mapped out, and the results, while advancing science, be of great practical value in navigation and the fisheries.

THE YELLOWSTONE NATIONAL PARK.

BY THEO. B. COMSTOCK, B.S.

II. ITS IMPROVEMENT.

HAVING shown, I trust conclusively, the value of the park from a scientific standpoint, we may now consider in a general manner the best and most advantageous methods of maintaining and utilizing its peculiarities. Before proceeding to the discussion of this subject, it will be well to state the provisions of the act of March, 1872, which relate specially to the control and improvement of the dedicated tract of land. I quote the following passages:

"All persons who shall locate or settle upon, or occupy the same, or any part thereof, *except as hereinafter provided*, shall be considered trespassers and removed therefrom."

"Said public park shall be under the exclusive control of the Secretary of the Interior, whose duty it shall be, as soon as practicable, to make and publish such rules and regulations as he may deem necessary or proper, for the care and management of the same. Such regulations shall provide for the preservation from injury or spoliation, of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition. The secretary may, in his discretion, grant leases for building purposes for terms not exceeding ten years, of small parcels of ground, at such places in said park as shall require the erection of buildings for the accommodation of visitors; *all of the proceeds of said leases, and all other revenues . . . . . . to be expended under his direction in the management of the same*, and the construction of roads and bridle paths therein. *He shall provide against the wanton destruction of the fish and game . . .* and against their capture or destruction for the purposes of merchandise or profit, ... and generally shall be authorized to take all such measures as shall be necessary or proper to carry out fully the objects and purposes of this act."[*]

It is impossible to find fault with this bill, so far as it goes, for it is a model of concise expression, while it is certainly explicit enough to show clearly its objects and intentions; nevertheless it is marked by one of those strange inconsistencies which seem inseparable from our present system of *unadvised* legislation upon matters connected with public improvements.[†] I refer to the authority given to the Secretary of the Interior and the duties thereby imposed upon him, without the power of exercising the one or of fulfilling the other. Ample provision has been made for the protection and preservation of the park and its denizens, *provided that no one attempts to injure or destroy within its borders.* But in this, as in other cases, the necessity which has produced the law demands its execution.[*] Thus far I am not aware that much has been lost by delay in this respect, for the simple reason that the mere fact that a law exists is sufficient for a short time to deter many from transgressing it. It has now become apparent, however, that there is no "power behind the throne," and so long as this state of affairs continues the danger of spoliation is liable to increase.

---

[*] So far as I am aware no further legislation has been made since the passage of this bill. I have omitted only those portions which refer to the boundaries of the park, with certain passages not essential to completeness of expression.

[†] I feel it to be due to myself, in consideration of a certain air of novelty or incompleteness which may attach to this article, to state more definitely my position with respect to the question of the relations of science to the General Government. I take this opportunity of recording my views upon this subject not only that I may be more fully understood in the plans here proposed, but also because I believe that the time has come for combined action on the part of scientists. In brief, then, it is my firm conviction that the present system (if such it can be termed) of *unorganized* and *indiscriminate* appropriation of the public funds for scientific purposes is, to say the least unprofitable and detrimental to the best interests of science. This conclusion, based as it is upon a careful study of the facts in the case, naturally leads to the question whether any method possessing equal or greater advantages could be adopted which would have fewer objections. After mature deliberation, I am confident that this is quite possible, as I shall hope to demonstrate hereafter. I cannot now enter into details, nor is it necessary for my present purpose, but these remarks may serve to explain in a measure what might otherwise appear paradoxical or impracticable.

Again, the bill does not provide for the improvement of the reservation in any way except that "all of the proceeds of leases, and all other revenues which may be derived from any source connected with said park," are to be expended in its management and the construction of roads. To say nothing of the fact that the first proceeds of such a fund, which is never likely to assume gigantic proportions, must be devoted to the payment of a superintendent's salary, it is evident that "the construction of roads and bridle paths therein" must precede "the erection of buildings for the accommodation of visitors." These roads must, therefore, be constructed in the early future, if the park is to become in any degree the place of resort for which it is intended.

As I have remarked, the whole of this district is now in a state of nature, and while this is by no means unfavorable to investigation, but, in many respects, quite the reverse, it is not conducive to a high state of physical vigor upon the part of the investigator. Until access to the Yellowstone Park from without and movement from place to place within its borders is rendered comparatively easy by the opening of suitable roads, food and other supplies must be transported by pack-trains a distance of more than one hundred miles. This method is not only tedious and expensive, but it is also attended with considerable risk, and the more delicate instruments which are indispensable for accurate work in some departments cannot be transported in this manner at all.[†] The first requirement for scientific work is, therefore, a system of roads which will afford communication between the principal points of interest. This accomplished, there can be no doubt of the speedy introduction of better methods of transport from without. The enterprising citizens of Montana and Wyoming, encouraged by General Ord, have already agitated the subject of an extended system of national highways through the Territories, and vigorous measures have been adopted to secure their object. This would add greatly to the facilities in this direction, for as I have shown, any direct route between the Montana settlements and the south or east must pass through this reservation or very near to it. But the project of a railroad through that section is not in its infancy, nor can it long be delayed. It is unnecessary to dwell upon these points, for it is obvious, from what has been said, that the attention of capitalists must soon be turned toward this field. I will therefore proceed to show in what ways I consider that the interests of science can be best furthered.

---

[*] President Grant, in his late message, recommends legislation to this end, and it is not improbable that it will receive the attention of Congress during this session. The Secretary of the Interior has done all in his power by the appointment, in 1872, of Hon. N. P. Langford, as superintendent. This gentleman has done far more than could be expected of him, and has regularly presented his reports, notwithstanding the fact that his services have been rendered with great sacrifice of comfort, and, so far as I can learn, wholly without compensation.

[†] Barometers and thermometers can only be carried with safety, by being packed with the greatest care, and strapped to the back of a rider who will rarely allow his animal to move out of a walk. The instances are rare indeed in which chronometers in

Too much stress cannot be laid upon the great importance of *prompt*, *constant*, *extended and connected observation* of the rare and rapidly waning phenomena, which form the most striking and characteristic features of the district under consideration. Taking these points in the order named, it ought to be understood that in order to obtain thoroughly satisfactory results

Action must be prompt.—The evidence thus far obtained, though meagre and fragmentary, points directly to the conclusion that constant changes are taking place in the movements of the geysers and boiling springs, resulting occasionally in the apparent extinction of an active crater, the sudden eruption of one long dormant, or a radical change in the manner of action of another.

The whole region abounds with traces of geysers, solfataras, and other minor evidences of the persistency of heat after the dying out of the volcanic furnaces, proving that the active vents are representatives of the last stage of such action. Several interesting geysers, to which I shall presently refer, have changed in character more or less since first observed.

The Giant Geyser was observed in action in 1870 by Lieut. G. C. Doane, who reports that the eruption continued during three and a half hours. At the time of Dr. Hayden's visit in the following year, the only eruption recorded, though quite as vigorous

---

use have been successfully transported upon horseback, even with the utmost care and precaution under very favorable circumstances.

as that mentioned by Doane, lasted only one hour and twenty minutes. This geyser was not observed in action by any of Dr. Hayden's party of 1872, nor by the members of the northwestern Wyoming expedition in 1873.*

If we are to reap the greatest benefit from the study of these phenomena, it cannot be denied that "delay is dangerous."

Observation must be constant.—The closest attention to details will avail little, however early, unless ample provision be made for its continuance without interruption. Temporary exploring parties have done their work so far as these are concerned, in the discovery and mapping of their positions, and in gleaning sufficient evidence to show their importance. Every scrap of this evidence is valuable, to be sure, but the main questions at issue can be decided only by the steady and laborious process of accumulating related and coincident facts. This necessity will be more apparent when we consider our ignorance of the phenomena. I can best illustrate this by a brief reference to the known history of several of the most prominent of the craters of the Upper Geyser Basin of Fire Hole River.

The eruption of the "Giantess" so graphically described by Mr. Langford,† who witnessed two violent eruptions within twenty-two hours in 1870, has since been observed only once, on the evening of August 18, 1872, by a portion of Dr. Hayden's party.‡

Another geyser a few rods distant from the "Giantess," but across the river, on account of the approximate regularity of its action, has received the appropriate name of "Old Faithful." I give on the following page a table of twenty-seven eruptions with particulars.§

---

* Dr. A. C. Peale, Hayden's "Report" 1872, p. 153, says:—"The water in the Giant Geyser seemed to be considerably agitated, but never reached a greater height than about three feet above the top." This was also its condition at the time of my visit last August. This is but one of many similar instances which might be given in illustration of my remarks.

† "Scribner's Monthly," June, 1871.

‡ Mr. Langford reports the maximum height of the column of *water* projected from this geyser to have been 250 ft. Dr. Peale (*loc. cit.*, p. 149) places the height, in 1872, at less than 10 ft.

§ The seventeen eruptions observed in 1872 are taken from the Report of Dr. Peale, (*loc. cit.*, p. 118). The remainder are from my own notes. Lieut. S. E. Blunt rendered material assistance in this instance.

TABLE.

No. of eruption.	Date.	Eruption began.	Eruption ceased.	Duration.	Intervals of quiet.
	1872.	h. m. s.	h. m. s.	m. s.	h. m. s.
1.	Aug. 17.	3 22 00 P. M.	3 27 00 P. M.	5 00	....
2.	Aug. 18.	7 27 30 A. M.	7 32 30 A. M.	5 00	....
3.	Aug. 18.	8 35 30 A. M.	8 40 30 A. M.	5 00	1 03 00
4.	Aug. 18.	9 40 30 A. M.	9 46 30 A. M.	6 00	1 00 00
5.	Aug. 18.	10 46 26 A. M.	10 51 13 A. M.	4 47	0 59 56
6.	Aug. 18.	11 54 31 A. M.	11 59 10 A. M.	4 39	1 03 18
7.	Aug. 18.	1 05 05 P. M.	1 09 46 A. M.	4 41	1 05 55
8.	Aug. 18.	2 15 25 P. M.	2 20 15 P. M.	4 50	1 05 39
9.	Aug. 18.	3 23 51 P. M.	3 28 22 P. M.	4 31	1 03 36
10.	Aug. 18.	4 33 22 P. M.	4 38 22 P. M.	5 00	1 05 00
11.	Aug. 18.	5 41 00 P. M.	5 46 00 P. M.	5 00	1 02 38
12.	Aug. 18.	6 42 30 P. M.	6 47 15 P. M.*	4 45	0 56 30*
13.	Aug. 18.	7 44 30 P. M.	7 49 20 P. M.*	4 50	0 57 15*
14.	Aug. 18.	8 51 00 P. M.	8 55 20 P. M.*	4 20	1 01 40*
15.	Aug. 19.	10 07 00 A. M.	10 11 45 A. M.	4 45*	....
16.	Aug. 19.	11 12 30 A. M.	11 17 20 A. M.	4 50*	1 00 45
17.	Aug. 20.	11 54 00 A. M.	11 58 20 A. M.	4 20*	....
	1873.				
1.	Aug. 25.	11 36 00 A. M.	11 41 30 A. M.	5 30	....
2.	Aug. 25.	12 39 00 P. M.	12 44 00 P. M.	5 00	0 57 30
3.	Aug. 25.	1 41 15 P. M.	1 45 45 P. M.	4 30	0 57 15
4.	Aug. 25.	2 45 20 P. M.	2 50 00 P. M.	4 40	0 59 35
5.	Aug. 25.	3 53 35 P. M.	3 58 00 P. M.	4 25	1 03 35
6.	Aug. 25.	5 11 10 P. M.	5 15 40 P. M.	4 30	1 13 10
7.	Aug. 25.	6 03 15 P. M.	6 07 45 P. M.	4 30	0 47 25
8.	Aug. 25.	7 12 00 P. M.	....	....	1 01 15
9.	Aug. 25.	8 14 00 P. M.	....	....	....
10.	Aug. 25.	9 17 00 P. M.	....	....	....

The following tabular list gives the number of recorded eruptions of ten of the best known geysers of the Upper Basin of Fire

---

[*] These data, for some unexplained reason, are omitted from Dr. Peale's table, and I have supplied them by simple calculation from the other figures which he gives.

Hole River. If there be any errors, it will be found that the total number is larger than the truth.*

NAME OF GEYSER.	No. of recorded eruptions.	Maximum height of column of water projected according to different observers.	Character of Geyser.†
		Feet. Feet.	
Old Faithful	30	100 to 150	Regular.
Giantess	3	39 to 250	Irregular?
Beehive	7	100 to 219	Irregular?
Castle	7	25 to 93	Fitful.
Grand	8	173 to 225	Regular?
Turban	3	25 to 30	Regular?
Giant	3	140 to 200	Constant.
Grotto	4	41 to 45	Irregular?
Saw-mill		15 to 25	Constant.
Riverside	3	40	Regular?
Total of recorded eruptions of nine of the best known geysers	68		

These facts not only tend to show plainly the paucity of our knowledge, but they furnish in themselves sufficient evidence of the amount which we may hope to gain by a closer study, based upon a wider knowledge resulting from constant observation.

Extended observation is required.—All of the expeditions which have heretofore visited this section have done so during the summer months; hence we have no records of any phenomena within these limits for a greater period than three consecutive months. The most interesting localities, consequently, have been in all cases very hastily examined. Dr. Hayden has published topographical maps showing the distribution of the principal geysers and hot springs of the upper and lower Fire Hole Basins, and of Shoshône Lake, to most of which he has given more or less appropriate names, but upon neither of his trips did he remain long enough in any one locality for extended observations. The expedition of last summer* was able to devote but a portion of the time to the area included in the park, and the remaining parties have been not only quite small, but they have been much more restricted for want of time.† All of the facts have been collected during the warmest and driest season of the year when the atmospheric precipitation is least abundant and permanent. We know absolutely nothing of the effects of climate upon the temperature, periodicity, or degree of activity of the subterranean waters, directly or indirectly. The relations, if any, existing between the different craters are almost equally undetermined. Even the sources of the water supply and the nature of the heating and projecting agencies are but vaguely understood. In fact nothing connected with the whole subject is well ascertained and the opportunity for *original* investigation is almost unlimited.

---

* This table is intended to include all known observations of eruptions made between 1869 and the present time. As a number of small parties of tourists, miners and others have from time to time visited this locality, it is probable that other eruptions have been witnessed, of which no records have been made in an accessible form. Several of the geysers in this list have also been seen in action by exploring parties without accurate observation. For obvious reasons, I have taken no account of such cases in my list.

† It is impossible from such a small number of ascertained facts, to classify these geysers *correctly*. In the case of "Old Faithful" enough is known to entitle it to be considered regular (approximately) in its action. The terms employed here to denote the character of the "Castle," "Giant" and "Saw-mill" geysers also express clearly enough their respective conditions, *at present*. As for the others, their status is very doubtful.

It is also quite possible, not to say probable, that many craters which have not yet been seen in action may hereafter prove to be among the most interesting and important geysers. Dr. Hayden describes, in his report for 1872, eruptions of geysers which were not observed the previous year, while two or three which were seen in action in 1871 were not observed in 1872. At least two new ones, I have reason to believe, were seen by myself during the summer of 1873, in the Upper Fire Hole Basin alone. Nor is this all, for there is little doubt that future exploration will be rewarded by the discovery of still other basins or collections of thermal and spouting springs. Notwithstanding the extensive surveys in our western wilds, there are many complicated problems to solve and numerous discoveries to make ere we shall fully realize the vastness and extent of nature's variety.

All observations should be connected.—Any system of observation, however comprehensive, will be comparatively futile, unless the work of all engaged shall be so connected as to prevent confusion and secure the strength of united effort. This proposition is obvious enough to need no demonstration. I will, therefore, pass directly to the subject next at hand.

---

*Northwestern Wyoming expedition.

†I am aware of no case in which any person capable of careful observation has spent so much as one week in recording a series of facts from one locality.

It will be seen, by reference to the bill previously quoted, that it is made the duty of the Secretary of the Interior to "provide against the wanton destruction of the *fish* and *game*, etc.," within the reservation. I have already given a list of the principal mammals and birds of this region,* from which those properly included under this head of *game* will readily be selected. Accepting this term in its widest sense, we may, perhaps, infer that this provision, if rigidly executed, will insure the protection of the greater number of the animals mentioned in this list. This, in a measure, secures the fulfilment of the scheme which I have proposed for the *preservation* of these animals. A moment's thought, however, will show the inadequacy of such means, for, in the first place not all of the forms included in my list are representatives of the park fauna, nor is it certain that mere *protection* would, in all cases, be equivalent to *preservation*.† Besides as I have stated, not a few of the species alluded to are well on the way to extinction, and great care might at times be required to prevent extermination. I have not space to consider these points as I could wish, but a few of the facts will not be out of place.

Among the *foreign* animals which I have suggested for introduction into the National "Zoological Gardens" is the bison, which, being erratic in its habits, would need some attention until egress from the park should become disadvantageous to it by the settlement of the surrounding country.‡

The American moose (*Alce Americanus* Jardine), the mule deer (*Cervus macrotis* Say), the big horn mountain sheep (*Ovis montana* Cuvier), and the mountain antelope (*Aplocerus montanus*), wrongly named the Rocky Mountain goat, are undoubtedly among the most valuable and interesting of the denizens of the Rocky Mountains, and I cannot believe that we have yet reached the limit of the adaptations of the order Ruminantia to the wants of man.*

---

* See First Part of this article.

† Besides the animals referred to, it seems to me quite possible to domicile in this region, a few at least of those species of other faunas which are in danger of rapid extermination; at any rate, experiments of this nature could do no harm, and they might often prove very beneficial.

‡ I have called the bison a *foreign* animal, because it is not now found within the limits of the reserved tract, but that it would thrive there if introduced is already proven by the abundant remains which are now bleaching in the valleys both within and adjacent to the park, showing that they have but recently been driven from these haunts.

The interesting case of the suckling of the young by the males of *Lepus Bairdii*, before mentioned, ought not to be overlooked, and there are doubtless many discoveries yet to be made of equal interest. The order Rodentia is well represented in this section.

There are many other points of greater or less importance which have occurred to me in connection with the plans of improvement which I have to suggest, but I must be content with a passing allusion to them. I cannot forbear, however, calling attention to one very prominent result to be attained by the setting aside of this tract, and the consequent preservation of the timber, as provided by law. It needs no argument to show the value of the Upper Yellowstone forests as a means of equalizing the distribution of the precipitated moisture, which is collected by the various streams radiating from this point. For many years to come, the timbered district within and around the park must be the main support of the settlements in that region, for without this influence irrigation during a considerable portion of the year will be impossible. Until artificial forests, so to speak, have been produced along the lower valleys of the streams, upon the plains, these timbered areas must constitute the very backbone of successful agriculture. Such being the case, there are few who will not welcome the introduction of most stringent measures for the protection of the wooded districts. Nor is this all, for there are, doubtless, not a few questions of much importance upon which new light will be thrown by the discoveries resulting from the preservation of new and rare forms of plants in these forests.†

---

*In the Report of the Dept. of Agriculture, 1867, p. 218, an anonymous writer gives a short article with a good plate of *Aplocerus montanus*, from which I extract the following:—"Mr. Lord deems the Aplocerus a valuable animal to acclimatize, and thinks it would thrive among the mountains of Scotland, and prove a remunerating 'wool-bearing animal.' Its coat is very thick, and is composed of two classes of hair, one extremely long and somewhat coarse, beneath which is a short, dense covering, very fine, 'as delicate in fibre and texture as that of the famous goat of Cashmere. The outer coat of hair is very long, covering the body, tail, and legs, like the fleece of the merino, being most abundant on the shoulder, neck, back, and thighs." . . . . "It would be worth while to ascertain more definitely the precise habits and capabilities of this American animal, and ascertain its pecuniary value, before searching farther through Asia for goats to acclimatize upon this continent, etc."

† That thousands of acres of valuable timber have been (not uncommonly) destroyed by the neglect to extinguish a camp-fire, is a fact which is patent to all who have trav-

The question now naturally arises, What can be done to carry out the several schemes proposed in this paper? This I shall endeavor to answer as fully and briefly as possible. There is one difficulty in dealing with all questions bearing upon the subject of government aid to science, which is that there exists no settled plan of action upon such matters. Those who are most deeply interested have neither time nor inclination to "lobby" for the passage of a bill, much less have they the means with which to purchase its passage by bribery, or the effrontery to offer it. Science is thus left dependent, in too many instances, upon the purely accidental good results which may follow or not, as the case may be. If the idea of a free national park for the benefit of the people is at all consistent with our republican institutions, nothing can be more plain than the duty of government to provide for its maintenance. But the Yellowstone Park, as we have seen, has manifestly a peculiar value aside from its utility as a mere "pleasuring ground," and thus it offers, without material outlay, unusual returns upon the investment.

For purposes of study, it would be best to divide the park into four nearly equal districts, with a small central district. The latter would comprise very few of the objects of great interest, but would contain the central station, which might best be located at the outlet of Yellowstone Lake. The four main districts would thus vary much in point of interest, but the work of research could readily be equalized by proper care and foresight. A chief commissioner, a person of acknowledged ability, occupying the central station, would then be placed in charge of the whole area, with competent officers under him and responsible to him for the performance of their duties. Each of the large districts should contain a principal station centrally located, and as many local stations as might be required for observation and experiment.[*] In other words, we should have what may be styled a perpetual expedition with head-quarters at the central station, composed of several divisions, working in separate fields, each provided with a competent scientific corps of investigators with their assistants.

I have given here the mere outline of a scheme which appears

---

elled through an uninhabited country. In the face of repeated warnings, there are many who will never learn to adopt the simple precaution of smothering their fires before abandoning them. It has been recommended, and not unwisely, that such wilful neglect should be made a criminal offence.

to me the most practicable and advantageous, simply because I have not the opportunity in this article to enlarge upon its scope and its adaptability to the end in view, but I believe that such a plan will be found adequate for the maintenance and utilization of the park in such a manner as to produce the most satisfactory scientific results; while, as I have shown, there is need of prompt action in some directions, it is not necessary, however desirable, that the whole of this plan should be inaugurated at once. On the contrary, time and money may be saved by beginning upon a small scale, and gradually widening the scope of observation. Eventually, however, such a scheme must lead to the introduction of observers in every important department of scientific research.

The most unpleasant part of the whole subject is the pecuniary difficulty, but I would gladly repose sufficient confidence in the culture of my countrymen, to believe that an enumeration of the immediate practical results to follow from this investment is unnecessary to convince them of its desirability. For the present, no method of accomplishing this plan seems available, except a grant from the General Government of an amount sufficient for the labors of a single year, but we may be justified in hoping that the judicious application of the first grant would render future appropriations more apparently necessary. It would not be difficult to demonstrate the propriety of a large endowment for the improvement of the park, but it is foreign to the objects of this paper, which have been to show the value of the tract, and, in a general manner, to show how it may be used to advantage, without discussing minutely the means to be employed for this purpose.

If the suggestions here made shall aid, in any degree, in advancing the cause of scientific research, more will have been accomplished than the writer has dared to hope.

THE GIANT CUTTLE-FISHES OF NEWFOUNDLAND AND THE COMMON SQUIDS OF THE NEW ENGLAND COAST.

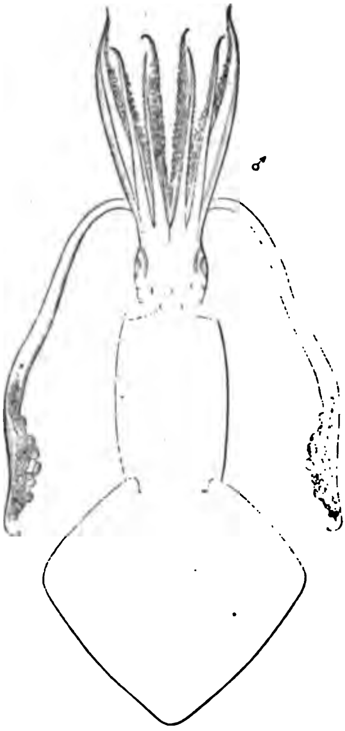
BY PROFESSOR A. E. VERRILL.

THE various accounts of the appearance and capture of several gigantic cuttle-fishes or "squids" on the coast of Newfoundland, that have recently been published in the newspapers, have excited an unusual interest in animals of this kind. I have been so fortunate as to obtain for examination and description the jaw of the huge specimen found floating at the surface on the Grand Banks in 1871, and referred to by Dr. Packard in his interesting article in a former number of the NATURALIST (vol. vii, No. 2, p. 91), and also the jaws and two of the large suckers of a gigantic specimen recently obtained in Bonavista Bay, Newfoundland,* and parts of another smaller specimen, captured in December near St. John. In a future article I propose to describe and figure these remarkable specimens, and will, therefore, at present, merely state that these remains show that two distinct kinds of gigantic squids exist on the coast of Newfoundland. One of these, represented by the jaw obtained in 1871, is a comparatively elongated species, having, according to the measurements made, a body about fifteen feet long and nineteen inches in diameter, with the ordinary arms about ten feet in length and seven inches in diameter (the two long extensile arms of unknown length). This is probably the *Architeuthis monachus* of Steenstrup, as stated by Dr. Packard. The other is represented by the jaws and suckers in my possession and by one of the long extensile arms preserved in the museum at St. John, Newfoundland, which was cut off from the individual that attacked the boat, as described in the February number of the NATURALIST, p. 120. Of this, I also have some of the suckers. Possibly a specimen, captured at Coombs Cove, was the same individual that attacked the boat, for, when captured, it had lost one of its long arms, and the one remaining agreed in dimensions with the one preserved. This is a comparatively stout species, having, according to the measurements made, of the last named individual, a body about ten feet long and three or four feet in diameter; the two long, slender, extensile arms were forty-two feet long; the shorter arms about six feet long and nine inches in diameter. One of the jaws of this species resembles the one figured by Dr. Packard (vol. vii, p. 93, fig. 10) as probably *Architeuthis dux* Steenstrup, and may be the same species.

---

* For these unique specimens I am indebted to Prof. Baird, of the Smithsonian Institution.

Fig. 54.



Loligo pallida, one-half nat. size.

A smaller specimen was captured in December, in Logic Bay, about three miles from St. John, in herring nets. Photographs were made of this: one showing the entire body, somewhat mutilated anteriorly; the other showing the head with the ten arms attached. The body of this specimen was over seven feet long, and between five and six feet in circumference; the caudal fin was twenty-two inches broad, but short, thick, and emarginate posteriorly on each side, the end of the body being acute; the two long tentacular-arms were twenty-four feet in length, and two and a half inches in circumference, except at the broader part near the end; the tips slender and acute; the largest suckers 1·25 inch in diameter, with serrated edges; the eight short arms were each six feet long; the largest two were ten inches in circumference at base; the others were nine, eight and seven inches. These short arms taper to slender acute tips, and each bears about one hundred large, bell-shaped suckers, with serrated margins. Each of the long arms bears about one hundred and sixty suckers on the broad terminal portion, all of which are denticulated; the largest ones, which form two regular alternating rows, of twelve each, are about an inch in diameter.

The general form and structure of these giants may be best understood by comparison with the common small kinds found on our shores, to which, in fact, the large ones are closely allied; moreover, their habits are in many respects quite similar.

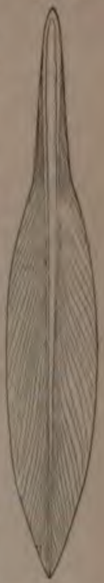
Of the smaller "squids," at least six species occur on the coast of New England, but some of these are quite rare.

Loligo pallida Verrill (figs. 54, 55). On the southern coast of New England, especially in Long Island Sound and near New York, the species represented by figs. 54 and 55 often occurs in large numbers, and is frequently captured in great quantities in seines, with menhaden or "bony-fish," upon which it probably feeds.

This species I have recently described under the name of *Loligo pallida*.*

The body is stout, tapering rapidly backward. Anterior border of the mantle with a prominent, obtusely rounded, median dorsal lobe, from which the margin recedes on each side; on the lower side the margin is concave in the middle, with a projecting angle on each side. Caudal fin large, about as broad as long, more than half as long as the body. Siphon large and stout; upper pair of arms considerably smaller and shorter than the others, slender at tips, margined along the inner dorsal ridge with a thin membrane. Second pair of arms stouter and longer, triquetral, slightly margined on the outer angle. Third pair much stouter and considerably longer, with a membranous fold along the middle of the outer surface, which expands into a thin membrane toward the end. Tentacular arms long and slender, in extension longer than the body. the portion that bears suckers forming about one-third the whole length; in the female the larger suckers on the middle of this portion are not so large as the largest on the other arms, and are arranged in about four rows; those near the tips of the arms are very small and crowded.

Fig. 55.



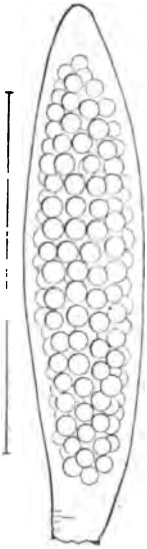
Quill of Loligo pallida.

---

*Report of the U. S. Commissioner of Fish and Fisheries, for 1871 and 1872, p. 635, plate 20, figs. 101, 101*a*. The description and figures are here reproduced with the consent of Professor Baird.

In the male the principal suckers of the tentacular arms are very much larger than in the female, and considerably exceed those of the other arms; they form two alternating rows along the middle of the arm, and external to them there is a row of smaller suckers on each side, alternating with them; the suckers toward the tips are very numerous, small and crowded; outside of the suckers, on each side, there is a marginal membrane with a scalloped edge; another membranous fold runs along the outer surface and expands into a broad membrane near the end; the arms of the ventral pair are intermediate in length between those of the second and third pairs. Ground-color of the body, head, arms and fins, pale, translucent, yellowish white; entire ventral surface pale, with small, distant, brownish circular spots, which are nearly obsolete on the siphon and arms; the upper surface is covered with pale brown, unequal, circular spots, which are not crowded, having spaces of whitish between them; the spots are more sparse on the head and arms, but somewhat clustered above the eyes. The general appearance of the animal when fresh is unusually pale and gelatinous. The "pen" is broad, quill-shaped, translucent and amber-colored. A medium-sized male specimen, preserved in alcohol, measures 145^{mm} from the base of the dorsal arms of the posterior end of the body; length of body, 120^{mm}; length of caudal fin, 70^{mm}; breadth of fin, 75^{mm}; length of first pair of arms, 42^{mm}; of second pair, 50^{mm}; of third, 60^{mm}; of tentacular arms, 150^{mm}; of ventral pair, 53^{mm}.

Fig. 56.



Egg Capsule of L. Pealii.

Loligo Pealii Lesueur* (figs. 56, 57). This is similar to the preceding species in structure, but is more elongated in form and much more highly colored. The color when living is very changeable, owing to the alternate contractions of the spots or color-vesicles, but these spots are much crowded, especially on the back, and the red and brown shades predominate, so as to give a general reddish or purplish-brown color.

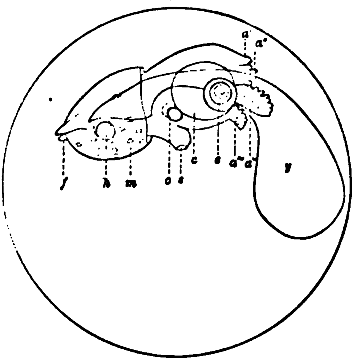
---

*This species is well represented by plate 25, fig. 310, in the last edition of Gould's Invertebrates. This figure was erroneously referred to *Ommastrephes Bartramii* by Mr. Binney.

This species when full-grown is over a foot in length, though most of those taken are smaller. It is very abundant in Vineyard Sound and Long Island Sound, and is taken in great quantities in the seines and fish-pounds.

The eggs of this and the allied species are contained in many elongated gelatinous capsules (see fig. 56), which are attached by one end to some common support, from which they radiate in all directions. These clusters are often six or eight inches in diameter, containing hundreds of the capsules each of which is from two to four inches long, and filled with numerous eggs. These are deposited in June and July. By the 20th of June many of these eggs contain embryos in different stages of development (see fig. 57).

Fig. 57.



Embryo of L. Pealii.*

Even at this early period some of the pigment vesicles are already developed in the mantle and arms, and during life, if examined under the microscope, these orange and purple vesicles may be seen to contract and expand rapidly and change colors, as in the adult, only the phenomena may be more clearly seen, owing to the greater transparency of the skin in the embryos. They are, therefore, beautiful objects to observe under the microscope. At this stage of development the eyes were brown. In these embryos the yolk is finally absorbed through the mouth, which corresponds, therefore, in this respect, to an "umbilicus." The more advanced of these embryos were capable of swimming about, when removed from the eggs, by means of the jets of water from the siphon.

During July and August the young, from a quarter of an inch to an inch in length, swim free at the surface, and may often be taken in immense quantities with towing nets. They were particularly abundant last summer, in Vineyard Sound, where large numbers were captured by Mr. Vinal N. Edwards, for the U. S. Fish Commission. These young squids are devoured in inconceivable numbers by fishes of many kinds, and also by the larger jelly-fishes, and many other marine animals.

---

* *a'*, *a''*, *a'''*, *a'''*, the right "arms" belonging to four pairs; *c*, the side of the head; *e*, the eye; *f*, the caudal fins; *h*, the heart; *n*, the mantle in which color-vesicles are already developed and capable of changing their colors; *o*, the internal cavity of the ears; *s*, the siphon; *y*, the portion of the yolk not yet absorbed.

The larger sizes, and even the adults, are also greedily devoured by blue-fish, black-bass, striped-bass, weak-fish, mackerel, cod, and many other kinds of fishes. Therefore these "squids" are really of great importance as food for our most valuable market fishes.

Ommastrephes illecebrosa. This is the most common squid north of Cape Cod, and extends as far south as Long Island, and Newport, Mass. It is very abundant in Massachusetts Bay, the Bay of Fundy, and northward. It differs from the species of *Loligo* in having distinct eyelids, and also in the more elongated form of its body and the shorter caudal fin. Its internal shell or "bone" is slender in the middle and expanded at each end, instead of being quill-shaped, as in the two preceding species. Messrs. S. I. Smith and Oscar Harger observed it at Provincetown, Massachusetts, among the wharves, in large numbers, July 28, 1872, engaged in capturing and devouring the young mackerel, which were swimming about in "schools" and at that time were about four or five inches long. In attacking the mackerel they would suddenly dart backward among the fish with the velocity of an arrow, and as suddenly turn obliquely to the right or left and seize a fish, which was almost instantly killed by a bite in the back of the neck with their sharp beaks. The bite was always made in the same place, cutting out a triangular piece of flesh, and was deep enough to penetrate to the spinal cord. The attacks were not always successful, and were sometimes repeated a dozen times before one of these active and wary fishes could be caught. Sometimes, after making several unsuccessful attempts, one of the squids would suddenly drop to the bottom, and, resting upon the sand, would change its color to that of the sand so perfectly as to be almost invisible. In this way it would wait until the fishes came back, and when they were swimming close to or over the ambuscade, the squid, by a sudden dart, would be pretty sure to secure a fish. Ordinarily, when swimming,

---

[*] This species is not well figured in the last edition of Gould's Invertebrates. Plate 25, fig. 339, which Mr. Binney refers to it, really represents a Loligo. Plate 26, figs 341—344 (erroneously referred to *Loligopsis pavo*), was probably made from a specimen of this species, but if so the long arms were incorrectly drawn.

they were thickly spotted with red and brown, but when darting among the mackerel they appeared translucent and pale. The mackerel, however, seemed to have learned that the shallow water was the safest for them, and would hug the shore as closely as possible, so that in pursuing them many of the squids became stranded and perished by hundreds, for when they once touch the shore they begin to pump water from their siphons with great energy, and this usually forces them farther and farther up the beach. At such times they often discharge their ink in large quantities. The attacks on the young mackerel were observed mostly at or near high water, for at other times the mackerel were seldom seen, though the squids were seen swimming about at all hours; and these attacks were observed both in the day and evening. But it is probable, from various observations, that this and the other species of squids are partially nocturnal in their habits, or at least are more active in the night than in the day. Those that are caught in the pounds and weirs mostly enter in the night, evidently while swimming along the shores in "schools." They are often found in the morning stranded on the beaches in immense numbers, especially when there is a full moon, and it is thought by many of the fishermen that this is because, like many other nocturnal animals, they have the habit of turning toward and gazing at a bright light, and since they swim backwards they get ashore on the beaches opposite the position of the moon. This habit is also sometimes taken advantage of by the fishermen, who capture them for bait for cod-fish; they go out in dark nights with torches in their boats and by advancing slowly toward a beach drive them ashore. They are also sometimes taken on lines, adhering to the bait used for fishes. Their habit of discharging an inky fluid through the siphon, when irritated or alarmed, is well known. This squid, like the preceding, is eagerly pursued by many voracious fishes, even when adult. Among its enemies are the full grown mackerel, who thus retaliate for the massacre of their own young by the squids.

The specimens observed catching young mackerel were mostly eight or ten inches long, and some of them were still larger.

A fresh specimen, caught in Casco Bay, had the following proportions: Length of head and body, not including the arms, 221^{mm}; length of caudal fin, 86^{mm}; breadth of fin, 90^{mm}; diameter of body, 35^{mm}; length of upper arms, 80^{mm}; of second pair, 100mm; of third pair, 100mm; of extensile arms, 182mm; of the ventral pair, 90mm.

The length of time required for these squids to become full grown is unknown, as well as the duration of their lives, but as several distinct sizes were taken in the pounds, and those of each school were of about the same size, it is probable that they are several years in attaining their full size. A specimen, recently caught, at Eastport, Maine, was pale bluish-white, with green, blue and yellow iridescence on the sides and lower surface; the whole body was more or less thickly covered with small, unequal, circular, orange-brown and dark brown spots, having crenulate margins; these spots are continually changing in size, from mere points, when they are nearly black, to spots 0·04 to 0·06 of an inch in diameter, when they are pale orange-brown, becoming lighter colored as they expand. On the lower sides the spots are more scattered, but the intervals are generally less than the diameter of the spots. On the upper side the spots are much crowded and lie in different planes, with the edges often overlapping, and thus increasing the variety of the tints. Along the middle of the back the ground-color is pale flesh-color, with a median dorsal band, along which the spots are tinged with green, in fine specks. Above each eye there is a broad lunate spot of light purplish red, with smaller brown spots. The upper surface of the head is deeply colored by the brown spots, which are here larger, darker, and more crowded than elsewhere, and situated in several strata. The arms and fins are colored like the body, except that the spots appear to be smaller. The suckers are pure white. The eyes are dark blue-black, surrounded by an iridescent border.

The remaining species are comparatively rare, and are seldom seen on our shores, their proper homes being probably farther north, or in mid-ocean.

Of the eight-armed group of Cephalopods, only one species, the *Octopus Bairdii* V., has hitherto been found on the New England coast (see AMER. NATURALIST, vol. vii, p. 394, July, 1873). It is not improbable that several other species of squids and Octopi remain to be discovered on our coast. Even the gigantic species taken at Newfoundland may also frequent the northern coasts of New England, or the deep water, off shore, for we really know very little of the active free-swimming animals that inhabit the great depths and cannot be taken with the dredge.

BOTANICAL OBSERVATIONS IN WESTERN WYOMING.

BY DR. C. C. PARRY.

No. 3.

THE very full botanical list contained in Hayden's Reports for 1871–72 includes most of the plants met with in the Upper Yellowstone basin, being comprised within the limits of the Yellowstone National Park. But as no attempt is made in the above reports to present the subject in its physiographical aspects, and the list as a whole embraces plants derived from other distinct botanical districts, I propose to continue the itinerary sketch of the botanical features presented on our route, noting the characteristic, peculiar, or undescribed plants as they are cursorily brought to view.

The elevated, irregular and bare mountain ridges that bound the Upper Yellowstone basin on the east command by far the finest prospect of this remarkable district. In approaching from any other direction, the distant view is mainly shut off by the dense pine forests that almost continuously cover the adjoining country; but from the Stinking Water divide, reaching above the timber line, the unobstructed view takes in the whole scope of adjoining woodland, the broad expanse of the lake with its deeply indented shores and rocky islets, and on a clear morning wreaths of misty fog, which, rising here and there out of the forest depths, reveal the locality of steam jets or boiling springs.

On leaving these attractive heights to plunge into the sombre forests, we soon lose the peculiar subalpine flora, which gives place to more common woodland forms.

Aquilegia flavescens of Watson is especially abundant with its loose straggling habit and light yellow blossoms, less showy than most species of this attractive genus.

Ledum glandulosum Nutt. is here noticed for the first time on our route, forming bushy clumps with laurel-shaped leaves, and scant clustered heads of white flowers.

Erythronium grandiflorum Pursh here presents in form and habit an exact western counterpart, on a larger scale, of our well known eastern species. Mosses and wood lichens in greater prefusion and variety indicate a moister climate; and along the borders of innumerable springs and ice-cold brooks grow the ordinary forms before noticed, including species of *Cardamine*, *Saxifraga*, *Mitella*, *Mimulus*, *Mertensia*, *Habenaria*, etc., etc.

The absence of any well-marked trails, and the annoying obstruction of fallen timber, obliging frequent détours, are apt to confuse the sense of direction even in those most experienced in wood-craft, and frequent reference to the compass is necessary to maintain a direct course. It is therefore a great relief, both to man and animals, to emerge occasionally into open grassy valleys, which offer something else to engage the eye and thought more pleasantly than dodging the scraggy branches of overhanging pine trees, or devising the best way of escape from a perfect maze of fallen trees. To the botanist especially these little open parks afford the most satisfactory field for observation and collection, however seriously interfered with by the persistent annoyances of insect pests. The Gramineæ here brought to view comprise the ordinary northern forms, including *Phleum alpinum* L., *Vilfa asperifolia* Nees and Meyen, *Agrostis scabra* Willd., *Muhlenbergia Mexicana* Trin., *Calamagrostis Canadensis* Beauv., *Calamagrostis Lapponica* Trin., *Kœleria cristata* Pers., *Melica bulbosa* Geyer., *Poa Andina* Nutt., *Festuca ovina* L., *Bromus breviaristatus* Thurber, *Triticum ægiopoides* Turcz, etc., etc. The Cyperaceæ are represented by *Eriophorum polystachyon* L., *Carex rigida* Good., *C. Jamesii* Torr., *C. Douglasii* Boott, *C. aquatilis* Wahl., *C. Raynoldsii* Dewey, *C. leporina* L. and *C. tenuirostris* Olney, ined.

On reaching the shore of Yellowstone Lake the great variety of exposure bordering this magnificent body of water, at an elevation of seven thousand four hundred feet above the sea level, added material attractions to the native flora. High bluff banks here alternate with stretches of sandy or gravelly beach, while numerous inland lagoons, frequently heated by boiling springs, maintain a local temperature often too high for the ordinary phænogamous plants. When, however, this source of internal heat is properly tempered, there is induced a profuse hot-bed growth. But the specific forms are not materially different from those elsewhere exhibited. Strikingly conspicuous among less showy plants were the profuse blossoms of *Gentiana detonsa* Fries, presenting flowers of unusual size, and streaked with the most delicate shades of azure blue. A peculiar form of *Pentstemon secundiflorus* Benth.

was equally distinguished by its brilliant colors and cultivated style of growth. Of other plants affecting such locations we may mention *Spraguea umbellata* Torr., *Chænactis Douglasii* Hook., *Eunanus Fremontii* DC., and, more singular in its associations with neglected fields and gardens, *Brunella vulgaris* L. and *Scrophularia nodosa* L.

Another peculiar plant of this district is that characterized by Dr. Torrey in Hayden's Report as a new genus of Lobeliaceæ, viz: *Porterella carnulosa* Torr. By some inadvertence the synonym of the original plant, described in Botany of Beechey's Voyage, page 362, under the name *Lobelia carnosula* H. and A, was quoted as *Lobelia carnulosa* H. and A., and the changed name adopted for the typical species of this proposed genus. It is still doubtful whether the distinguishing characters are sufficient to entitle this plant to generic rank as distinct from Lobelia. The localities in which it was invariably found were recently exsiccated pond-holes in open grassy valleys, which it adorned profusely with its delicate blue flowers; it was here quite constantly associated with *Nasturtium curvisiliqua* Nutt.

While searching in similar localities near the falls of the Yellowstone for fruiting specimens of the latter plant, my attention was directed to a dense subaquatic growth, occupying the basin of a shallow muddy pond. This proved to be *Isoetes*, which Dr. Engelmann, who has assiduously studied this difficult genus, has characterized under the name of *Isoetes Bolanderi* var. *Parryi*. (See Appendix, No. 307.) The numerous additions to this genus, lately made under the inspiring influence of Dr. Engelmann's researches, show how largely dependent is the introductory work of the botanical collector on the supplementary labors of the herbarium botanist.

On the elevated grassy slopes, which at different points afford an agreeable relief to the uniform forest growth, we invariably encounter a well marked subalpine flora in the prevalence of such attractive forms as the following, namely: *Caltha leptosepala* DC., *Oxytropis nana* Nutt.? *Astragalus Kentrophyta* Gray, *Bupleurium ranunculoides* L., *Aster pulchellus* DC. Eaton, *Erigeron ursinum* DC. Eaton, *Aplopappus suffruticosus* Gray, and *Senecio amplectens* Gray. At lower elevations the same open character of country, agreeably set off with copses of *Abies grandis* Lindl., afford a still larger number of interesting forms, including *Ribes* *viscosissimum* Pursh, *Peucedanum leiocarpum* Hook., *Ligusticum scopulorum* Gray, *Lonicera cærulea* L., *Aster conspicuus* Lindl., *A. integrifolius* Nutt., *A. elegans* Torr. Gray, *A. Engelmanni* Gray, *Senecio triangularis* Hook., *S. Andinus* Nutt., *Hieracium Scouleri* Hook., *Gaultheria myrsinites* Hook., *Orthocarpus Parryi* n. sp. Gray (see Appendix, No. 218), *Echinospermum deflexum* Lehm., *Spiranthes Romanzoffiana* Cham., *Fritillaria pudica* Spreng., *Calochortus eurycarpus* S. Watson, *Botrychium simplex* Hitchcock.

At the head of Yellowstone Lake, fringing the muddy shores of one of its numerous inlets, was found in great abundance the well known European plant, *Subularia aquatica* L. This has been regarded as one of the rarities on the American continent, and has been termed by Dr. Gray one of "the late lingerers" which has just managed to maintain its foothold in a few isolated New England lakes: but it seemed to be quite at home on the banks of the Yellowstone. While it is by no means unlikely, as suggested by Dr. Gray, that from its diminutive size and mode of growth, it may have been overlooked in intermediate localities, its occurrence here, in such profusion, so remote from any recognized connection with an ancestral source, is very suggestive in its bearing on the question of geographical distribution, and derivative origin of species. Certainly the localities on this continent where it might have persisted, if originally spread round the northern hemisphere, are sufficiently numerous not to leave such wide gaps as that between Maine and Wyoming! Doubtless, as in other apparently unaccountable cases, future discovery either east or west will help to fill up this chasm.

In the numberless ponds and lagoons which occur near the head of Yellowstone Lake only the usual forms of northern aquatic plants were noticed, including *Ranunculus aquatilis* L., *Nuphar advena* Ait., *Utricularia vulgaris* L., *Lemna trisulca* L., *Typha latifolia* L., *Sparganium simplex* Huds., *Zannichella palustris* L., *Potamogeton perfoliatus* L.

In none of these promising localities was I able to detect the *Nuphar polysepalum* Engel., which seems singularly to affect isolated localities.

The various confervoid growths and obscure vegetable organisms in connection with the numberless hot springs of this region will no doubt reward the special researches of the microscopical botanist with new and peculiar forms. Before taking final leave of the Yellowstone Park district, it may be proper to allude briefly to the character of the forest growth, so obtrusively forced on the attention of the traveller. Not less than ninety-nine per cent. of the pine growth of this district is made up of the single species, *Pinus contorta* Dougl. Mile after mile of continuous forest may be traversed without seeing any other arborescent species, and their tall, straight, uniform trunks and scattering foliage will be always associated with the monotonous and disagreeable features of the park scenery. Only where the blazing camp-fire sends forth its grateful warmth to relieve the ordinary chill of a night temperature, where the thermometer in August ranges between 36°F. and 14°F., do we realize a manifest utility in this wide-spread forest production. Occasionally, in low moist ground, the balsam (*Abies grandis*) comes in to vary the sombre scenery, and add a deeper gloom to these shaded recesses. On higher mountain ridges, *Abies Engelmanni* Parry makes its appearance, always indicating an elevation of between eight thousand and nine thousand feet above the sea. With this latter is associated, as in the higher mountains farther south, *Pinus flexilis* Torr., but at no point was seen in this district the more exclusively alpine form, *Pinus Balfouriana* Murray.

Abies Menziesii Lindl., which is credited to the park district in Prof. Porter's list, was not seen by me, and as my attention was particularly directed to this subject of forest distribution, it could hardly have been overlooked. It is possible that some of the peculiar forms of *Abies Engelmanii*, in which the cones with their lengthened scales approach *Abies Menziesii* (though still plainly distinct), may have been mistaken in herbarium specimens for this latter species, which was not met with on our route after leaving Wind River valley.

Our route from the southern head of Yellowstone Lake passed by an almost insensible grade to one of the numerous eastern branches of Snake River; thence, skirting along the irregular mountain range to our left, we passed in full view of the Grand Tétons on our right, from which, making a sharp détour to the east, we reached a low divide at the head of Wind River. On this part of our route, being late in the season and on a hurried march, but little opportunity was afforded for botanizing. The general aspect of the flora, as judged from the autumnal forms, was not materially different from other districts passed over in our previous route. Of plants not elsewhere noticed may be mentioned *Sphæralcea acerifolia* Nutt. and *Rudbeckia occidentalis* Nutt. Near the summit of the high rocky peak overlooking Snake and Wind River valleys, was found a new species of Draba characterized by Dr. Gray, under the name of *Draba ventosa* n. sp. (see Appendix, No. 15) : also *Aster montanus* Rich, the latter only known from high northern collections in British America.

From this accessible pass, by which the Yellowstone Park can be reached on a very direct route, we passed rapidly down the open valley of Wind River and reached our previous rendezvous at Camp Brown, on September 12th, after just two months' absence.

NOTE.—An appendix, containing characters of new species, etc., will follow and conclude this series of articles.

REVIEWS AND BOOK NOTICES.

THE ZOOLOGICAL RECORD FOR 1871.*—To those who live away from libraries and would keep themselves informed as to the annual progress in any department of descriptive zoology, this record is invaluable. Working naturalists, also, more favorably situated, cannot do without it. We have found but few omissions in it, and American articles and memoirs are faithfully reported. The volume has been slow in making its appearance, and we hope better fortune and better health will fall to the lot of the editor and his assistants in the preparation of the volume for 1872.

BOTANY.

THE FERTILIZATION OF GENTIANS BY HUMBLE BEES.—The closed gentian (*Gentiana Andrewsii*) has flowers an inch and a quarter or more in length. These inflated, bright blue flowers of late autumn appear to be always in the bud, as they never open. The corolla is twisted up so as to leave no opening at the top. The flowers are all nearly erect with two stigmas considerably above the five anthers. I see but one way in which it can be fertilized, that is by insects. Several of my students, as well as myself more than two years ago, have often seen humble bees entering these flowers. They pry or untwist the opening with their mouth organs and legs, and then pop into the barrel-shaped cavity, which they just fill.

---

* Being vol. viii, of the Record of Zoological Literature. edited by Alfred Newton' London. 1873. Van Voorst. 8vo. pp. 496.

THE DESMIDS.—O. Nordstedt has published in the part bearing date 11th Sept. of the "Lunds Universitets Arsskrift" an extensive memoir on the *Desmideæ* of S. Norway; over 260 species are described, of which some 20 or more are new. In the same journal Nordstedt describes and figures a new species of *Spirogyra* from Scania (*S. velata*).—*Journal of Botany.*

ZOOLOGY.

ENTOMOLOGY IN MISSOURI. — On pages 471–7, vol. vii, there is a flattering notice of the fifth Missouri Entomological Report, which notice, though lacking the familiar initials A. S. P., is, I infer, from the pen of one of the editors and a co-worker in the cause of economic entomology, who frequently writes over those letters. The notice contains some strictures which call for a reply:

> (1) As morphology indicates by the presence of four pairs of jointed appendages in the head, and embryology demonstrates by their early presence, four rings in the head, our author's definition of an insect as 13-jointed does not express the whole truth. (2) He should say 17-jointed, or 14-jointed, counting the head as one, in a popular report of this sort. (3) Four rings can be demonstrated in the head of an insect as easily as that the petals of a flower are modified leaves.

(1) It hardly becomes one who, if my assumption is correct, has in his own writings put forth different opinions as to how many "*typical*" joints the head of an insect is composed of, to say with such assurance, that embryology "demonstrates" that it is composed of four. The comparatively few species that have been studied embryologically will scarcely warrant our receiving such a statement as an established fact, in face of the many objections that can be brought against it. Most morphologists, believing with Sir Jno. Lubbock that there exists between Crustacea and Insecta a physiological relation analogous to that existing between water and land vertebrata, have been inclined, with Straus-Durckheim, to consider the insect head as 7-jointed, and the insect body as 20-jointed. This is a very desirable number to

give force to the idea of community of descent between these two classes, and community of structure in their exo-skeletons. But neither those who advocate 7 joints to the head, nor those who advocate 4, or 3, or 2, can claim that their particular views are demonstrated; and until they are demonstrated the advocates of the 1-jointed nature of the head have the advantage and will naturally relegate the other propositions to the limbo of pure theory. It is, moreover, difficult to conceive how those who include Arachnids and Myriopods under the term Insect can believe in any present community of structure between them.

My own view of this matter is not badly set forth in an excellent memoir by Dr. H. Schaum "On the Composition of the Head, and on the Number of Abdominal Segments in Insects,"* and to defend it properly would require a whole number of the NATURALIST, and involve a discussion of the value of the speculations so freely indulged in on this head. For this I have neither time nor inclination, and a few words must suffice. I can see no good reason why the jointed appendages of the head should be made to represent separate head segments, any more than the non-jointed appendages; and if any good reason could be given, it ought to apply to the jointed legs of the thorax as well. Yet the apodous insect larva DEVELOPS jointed legs as well as the legged larva. To me the idea that the head is composed of four joints is not a whit more tenable than the opinion that the thorax is composed of six. As Schaum has well said, it is a general law that an insect leaves the egg with the full complement of joints and none are ever added during metamorphosis. Yet many larvæ have a head without the slightest trace of a division into subjoints, and such are frequently blind or even destitute of antennæ, though their imagines possess both eyes and antennæ. Now, how can these organs be said to represent, or be developed from, joints which never had an existence?

(2) I have the satisfaction of being in most excellent company from the days of Lyonet to those of some of our best modern authors, in considering an insect 13-jointed; and to be told that I *should* "say 17-jointed or 14-jointed" does not carry that conviction which the authoritative tone might be supposed to possess. My own experience fully corroborates the views of those authors who consider that in no instance does the number of joints, in

---

* Ann. and Mag. Nat. Hist; London, vol. xi, 3d ser., 1863, pp. 173-182.

true insects, exceed thirteen, though it may fall short of this number, as in the larvæ of *Hydrophilidæ* which have but twelve. This fact is plainly seen in all insects undergoing complete metamorphoses, where the head constitutes one, the thorax three and the abdomen nine joints. In some insects undergoing incomplete metamorphoses, and notably in *Libellulidæ*, an apparent tenth abdominal joint is visible; but Dr. Schaum, in the article alluded to, has very conclusively shown that what is generally mistaken for the first abdominal joint is but a posterior portion of the metathorax, and I know from conversation with, and from notes and correspondence of my late friend Walsh, who gave this question much study, that he was of the same opinion. A more or less distinct terminal subjoint is also often noticeable at the extremity of the body in many larvæ, and I especially called attention to this fact, when making the statement criticised, and cited as a prominent example, the larva of *Passalus cornutus.*[*]

In reality, as Erichson and Stein have proved,[†] this is nothing but the externally protruded anus, analogous to the anal proleg of the larvæ of many Coleoptera. The fact that dipterists have characterized the Cecidomyidous larva as differing from all other insect larvæ in having fourteen joints shows how universally the insect body is considered 13-jointed; and I have already stated my belief,[‡] after examination of many species, that these larvæ form no exception to the rule of having thirteen joints and a subjoint. Strictly speaking, therefore, the body of an insect is composed of thirteen joints and a subjoint; and if we wish to employ a more arbitrary definition, the number 13 will more truly and generally apply than either 12 or 14.

(3) I have shown above that I do not believe this to be a truth; and even if it were irrefutably demonstrated that the head of an insect is composed of four elementary or embryonic joints, I should still speak of it as a single joint in referring to an insect out of the egg; for nothing would be gained, especially in a popular work, in which the abstruse in thought or expression should always be avoided, by substituting the ideal for the real. Though the petals of a flower be modified leaves, we still distinguish them as petals; and he who would attempt to do away with all the dis-

---

[*] 5th Rep., p. 7, note.

[†] Vergleichende Anatomie der Insecten, quoted by Schaum.

[‡] 5th Mo. Rep., p. 114, note.

tinctive terms, as wing, fin, arm, etc., used to designate the known modifications of the same embryonic organ, would not, to my mind, cause more confusion, or be less justified, than is he who calls an insect's body 17-jointed simply because what is so palpably a single joint, was originally formed out of four embryonic joints. There is a fundamental unity of elementary structure and composition (as no one better knows than my reviewer) of all living beings; and animal and plant may alike be traced to, and have their origin in, the simple cell. Embryologically, therefore, all animals may be said to be alike, and in making our classificatory distinctions we necessarily refer to the perfected or ultimate structures.

(4) Mr. Riley also takes a back step in classification in separating the Strepsiptera from the Coleoptera, the fleas from the Diptera and the Thysanoptera from the Hemiptera. (5) It is strange if over thirty years of observation should not enable us to advance beyond Westwood's classification, admirable in 1840, but in many respects obsolete in 1873. (6) Again, our author states that embryological data "though of great value as pointing to the derivation of insects — their homologies and relations to the past — do not always subserve the best interests of classification." We would inquire what is classification but an attempt at tracing the genealogy of animals or plants?

(4) A few quotations will, I think, best refute the charge. Speaking of the Strepsiptera I distinctly say "now classed with the *Coleoptera;*" speaking of the Aphaniptera I say "now placed with the *Diptera* (5th Rep., p. 15); speaking of the Thysanoptera I distinctly state that they "may be placed with the *Pseudo-neuroptera*, though bearing strong relations to the *Hemiptera* (*ibid.*, p. 16); and I finally conclude my consideration of these osculant groups with the following sentence: — "As already stated, if separated from the other orders, these abnormal groups should, at the most, be considered as Suborders; and in reality they differ no more from the orders to which they are here referred than, for instance, the bark lice (*Coccidæ*) do from the more typical *Homoptera* from which no one thinks of separating them" (*ibid.*, p. 16).

(5) This stricture was doubtless inspired by the following quotation from that part of my Report which refers to the different systems of classification, and which I quote because it helps me to answer both the fifth and sixth strictures. "Remembering that classifications are but means to an end — appliances to facil-

itate our thought and study; and that, to use Spencer's words, 'we cannot, by any logical dichotomies, accurately express relations which, in nature, graduate into each other insensibly,' the difference of opinion becomes intelligible; and for my part I adopt that system which appears most natural, and which best promotes the object in view. It is essentially that of Westwood, given in his 'Introduction,' which has justly been called the entomologist's bible." Perhaps this language conveys the idea that I believe we have made no advance beyond Westwood's classification; but if so, it belies my meaning, and I have simply been unfortunate in expression! And as facts never become obsolete, and the "Introduction" referred to contains more facts, and fewer theories and speculations than many later published entomological works, I do not think it undeserving the homage paid to it, though it be "in many respects obsolete in 1873."

(6) I have already answered the inquiry, in my feeble way, in the above extract: and as to my opinion of the value of embryological data in classification, I shall content myself, at present, with adducing in its support the opinion of one who is infinitely better qualified to form an opinion which has weight. After referring in his last annual address, before the London Entomological Society, to Packard's "Memoir on the Embryology of Chrysopa, and its Bearings on the Classification of the Neuroptera," and to the opinions arrived at by the author, Westwood concludes as follows:—"And thus the position of the animal in the ovum is allowed to unite into one group Libellula with its active, and Hemerobius with its necromorphous pupa; and to separate widely Hemerobius and Phryganea, both with inactive pupa, which are, however, furnished with jaws of a structure, *per se*, for biting a hole in the cocoon before arriving at the fully-developed imago state. I confess that this specimen of classification founded upon embryological data does not carry to my mind conviction of its superior worth."

The accompanying figure (117) represents the male of the apple bark louse, which Riley calls *Mytilaspis pomicorticis*, regarding it as distinct from the *A. pomorum* Bouché of Europe, from the fact that the eggs of the European species are reddish-brown, while those of our species are white. Care should here be taken in ascertaining how soon after being laid the eggs are observed, as they may vary in color with the age of the embryo within. Certainly we have been unable to detect any difference between the bark louse of the apple as we have observed it in Jena, Germany, and

> our species, having compared numerous specimens of both. Undoubtedly our species has been imported from Europe, and it would have been the better way, we think, to regard our species as identical with the *M. pomorum* (Bouché) than to give it a new name.

Now this is not very consoling after having devoted nearly three pages to the reasons for the course pursued, in which pages every point made in the above extract is carefully met and effectually broken. It is all the less so that my reviewer has himself named species on very unsatisfactory grounds.* I have studied *Mytilaspis pomicorticis* for many years, and emphasized the fact that its eggs are never, at any stage of development, reddish-brown, and that the color of the egg is a most important character in distinguishing the closely allied *Coccidæ*. I expressly stated my belief that the European insect mentioned by Curtis, Boisduval, Taschenberg and others is identical with our's, and showed that in Europe as well as in this country it had generally been considered as Gmelin's *conchiformis* which, however, applies to a similar species found on the elm in Europe, and not to the apple tree species under consideration. No one, until last year, even so much as thought of referring our insect to Bouché's *pomorum* to which, indeed, it cannot be referred; and I regret that my views and the reasons for them are not better represented in the above-quoted stricture.

The truth is, that if, following the highest authority, we consider several very closely allied forms of Mytilaspis as specifically distinct, the European apple tree species with white eggs, which is the one imported into this country, was, up to the appearance of my last Report, erroneously referred to *conchiformis* Gmélin; and they either have a closely allied species in Europe, with reddish-brown eggs, or else Bouché's description is so false in one of the most important characters that it is valueless, and should be ignored as, indeed, it always has been. In either case, the American pomologist will appreciate more kindly than my reviewer the efforts to "brush away the cobwebs of uncertainty which have gathered around the nomenclature of the insect," and to couple an appropriate name with a description and history which cannot in future be misunderstood.

---

* The orange suffers greatly from the attacks of scale insects, and, among others, of a species of Mytilaspis so closely allied to *M. pomicorticis* that no distinguishing features have yet been pointed out. The fruit which comes to the St. Louis market is often covered with the scales, and Capt. E. H. Beebe, of Geneva, Ill., last spring sent me oranges so badly infested that the scales were two and three deep; some being broad and others more linear as is the case with all the allied species. As far back as 1850 M. Ch. Delacour, in an essay on insects which attack fruit trees, considered it identical with the apple tree species, and I am unable to find any specific differences at all reliable in the dead insects. The only way in which it can be properly separated from *pomicorticis* is by critical comparison of the living males and females of both. In the Patent Office Report for 1855, Mr. Glover gave an account of this orange species and of its introduction into Florida, but without naming it. From his imperfect figures and without giving any characters of specific value, Mr. Packard (Guide, etc. p. 527) makes two new species, viz., *Aspidiotus Gloverii* and *A. citricola*.

Praying your indulgence for the length of this defence, I thank you, Messrs. editors, for the appreciation otherwise manifest in the review in question.—C. V. RILEY, *Dec.* 3, 1873.

[I should not feel called upon to notice Mr. Riley's reply to my criticism, were not the views on morphology he here reiterates in my opinion so erroneous. In reply to his section 1, I may say that the reader is referred to p. 19 of the third edition of the "Guide to the Study of Insects" for my reasons for changing my opinions as to the *number* of segments in the head of six-footed insects, and on p. 18, will be found an account of the opinions of the best authors as to the composition of the head of insects. The whole matter was settled by Savigny in 1816, and confirmed by Audouin, MacLeay, Kirby, Carus, Straus-Durckheim, Newman, Newport, Huxley and others, and by every writer on the embryology of insects. If Mr. Riley, after reading the views of these authors, and studying for himself the embryology of some insect, is content to reiterate his own and Dr. Schaum's views so confidently, I shall admire his hardihood.

2. The article of Dr. Schaum is really based on such ignorance of morphology and embryology, and is so unphilosophical in its spirit, that I wonder any one can be found to endorse it. That "what is generally mistaken for the first abdominal joint" is that joint was shown to be so by Latreille, Newman and others, and I may be pardoned for saying that I believe I have proved it by an examination of the segment in question in the larval and pupal stages of the humble bee.*

3. That the head of an insect is composed of more than one segment is simply a matter of fact; there is nothing "ideal" about it. The simple fact that the head of an insect bears four pairs of jointed appendages (*i. e.* the antennæ, mandibles, and two pairs of

---

* See observations on the Development and position of the Hymenoptera, etc. Proceedings Boston Society of Natural History, 1866, vol. x, p. 279, and "Guide to the Study of Insects," p. 66.

maxillæ) indicates that it must be composed of four segments, while an examination of the head of an adult insect indicates that all the different pieces composing it cannot be referred to a single segment. Would it not be better in a "popular work" to tell the truth of the matter, and thus lead the reader to take an interest in the study of the morphology of insects, that highest department of biology, than to lead him blind-fold past some of the grandest truths in science?

4. My good friend is quite wrong in intimating that those larvæ which have heads " without the slightest trace of a division into subjoints," and are "blind or even destitute of antennæ," never had cephalic segments. If he will study Weismann's famous work on the embryology of insects, he will see that in the embryo of the flesh fly, the four segments and appendages are as distinct as in the embryo of the bee, Hydrophilus, or other beetles. The appendages become obsolete, though not wholly so, just before hatching, and Mr. Riley will probably agree with me that the differences between a "headless" maggot and a caterpillar or bee larva are probably due to differences in their mode of life. The organs are all there at the outset, in the embryo. I think Mr. Riley will set a higher value on "embryological data," after perusing the works of Rathke, Herold, Kölliker, Zaddach, Leuckart, Huxley, Claparède, and especially Weismann and Kowalevsky.

Whether my criticism on the matter of the apple bark louse was hasty and incorrect I leave to others to decide.—A. S. Packard, Jr.]

A new North American Bird.—On the 5th of July last Ludovic Kumlien, a son of Thure Kumlien, the well known ornithologist of Wisconsin, shot on Lake Koshkonong, in the central part of southern Wisconsin among a flock of the *Hydrochelidon fissipes*, a bird which he at once recognized as something entirely new to our fauna. It was a mature female and was found to contain well developed ova, though not fully grown. Mr. Kumlien, Sr., who is familiar with European forms, at once recognized it as the *Hydrochelidon leucoptera* and this determination has since been confirmed by Prof. Baird.

The *H. leucoptera* is a well known European form more common to southern Europe than farther north and has never before been known to occur on this continent. That one should be found so far in the interior of Wisconsin, a thousand miles from the coast, is somewhat remarkable, and naturally suggests the idea that this species may be found not so very rare, but that it may occur elsewhere and have been mistaken for *fissipes*, which is a cosmopolitan bird, and is found both in America and Europe. Its principal difference from the *fissipes*, consists in its white tail, and it will be well for naturalists in various parts of the country to be on the lookout for a white-tailed tern.—T. M. BREWER.

P. S. Mr. Robert Ridgway has kindly made the accompanying description of this new acquisition to our fauna:—

Wing. 7·50; tail, 2·00; culmen, ·90; tarsus, ·75; middle toe, ·65. Head, neck and lower parts to the anus, including the lining of the wings, uniform plumbeous-black; anal region, crissum, and upper tail coverts, immaculate snowy white; tail white, tinged with ashy. Mantle dark plumbeous, shading insensibly into the black of the nape; wings lighter, more hoary, plumbeous, becoming gradually white at the anterior border of the lesser covert region; primaries like the mantle, but more hoary, their shafts pure white. Bill, purplish black, the lower mandible more reddish; legs and feet deep orange-red.

This specimen is very similar to a European one in the Smithsonian Collection, but differs in having the upper tail-coverts and tail much purer white.

ECONOMIC ENTOMOLOGY.—Dr. LeConte's excellent paper, on "Hints for the Promotion of Economic Entomology in the United States," will be read with much interest, and do great good. The call for the expansion and reorganization of the Department of Agriculture is opportune and meets a similar and constantly increasing demand for such a reorganization from the agriculturists of the country and especially of the west. The few real farmers, sprinkled with the mass of lawyers, politicians, merchants and professional men, who go to make up the bodies composing our state and national legislatures, seem to have had little voice in the past, in the filling of offices created ostensibly for their benefit.

It is a burning disgrace that the agricultural interests of the country, which form the basis of our national prosperity, should have been represented in the seat of government by an untutored market-gardener like Isaac Newton; or should still be represented by one who is so little in sympathy with the progressive agricultural spirit, and who seems to give so much dissatisfaction, that hardly an agricultural journal in the land speaks a word in his favor. With a man at the head of this department, possessing large culture and scientific attainment, like Dr. LeConte, or extensive agricultural knowledge and great executive ability, like

W. C. Flagg, J. P. Reynolds or H. D. Emery of Illinois; or experience and popularity, like C. R. Dodge or Wm. Saunders (both at present connected therewith), there can be no doubt that it would be infinitely more efficient in promoting the interests for which it was created, and less open to criticism.

The agricultural interests of the country demand more attention and better representation. If our merchants lost one tithe of what our farmers annually lose from insect depredations alone, they would immediately seek and undoubtedly obtain adequate protection from the government; for the simple reason that they are organized and work as one body. The farmers, heretofore, have been disconnected—a mere rope of sand, without concerted plan or object. But at present they are building up a powerful organization which is rapidly extending its strengthening and unifying arms over the whole country. It is an organization which, if not perverted from its original aims, will soon become a very powerful lever in the promotion of the agricultural interests. May we not hope that through its instrumentality the plans and suggestions made by Dr. LeConte will at no distant day be realized!

In measures five and six (vol. vii, p. 722) as propounded in the paper, for the wholesale destruction of noxious insects, I have little confidence. Fires, lights, vessels of attractive or poisonous liquids are constantly recommended as means of counteracting the work of injurious insects; but my experience with them has been very unsatisfactory. Usually quite as many beneficial as injurious species, and very seldom any really injurious species, are thus captured; and at the best such measures are blind and inefficient ways of effecting that which can be otherwise effected with more certainty and satisfaction.—C. V. Riley.

GEOLOGY.

Remains of Land Plants in the Lower Silurian.—M. Lesquereux contributes an article to the "American Journal of Science and Arts" for Jan., 1874, in which he reports the discovery near Lebanon, Ohio, of fragments of Sigillaria in clay beds positively referrible to the Cincinnati group of the Lower Silurian. This is a remarkable discovery, as no land plants before this had been found lower down than the Lower Helderberg division of the upper Silurian in Gaspé, Canada. In Europe no land plant has yet been found below the Lower Devonian.

MICROSCOPY.

Embedding Tissues for Section.—Dr. William Rutherford, of King's College, London, prefers to embed tissue, which is to be cut without freezing, in a mixture of paraffine (5 parts) and hog's lard (1 part) melted together; this mixture melting at a lower temperature than the wax and oil mixture, and being less liable to become loose by shrinkage in cooling. Tissues that require freezing are to be embedded and frozen in a solution of gum arabic (5 oz.) in water (10 oz.) and spirits of camphor (2 dr.), which, when solidified by cold, slices "as easily as a piece of cheese." Dr. Rutherford's microtome consists essentially of a cylinder with a piston moved by a screw, the upper portion only of the cylinder, where the object is, being surrounded by a box to contain the freezing mixture, of powdered ice and salt; the freezing box is surrounded by flannel, and the water continually forming in it is drained off by a tube through the bottom of the box.

Dissecting Embryos.—W. K. Parker, Esq., late president of the Royal Microscopical Society, dissects early embryos under water, pinning them upon a cake composed of lamp-black and paraffine.

NOTES.

The Memorial to Agassiz bids fair to be of such a character as will be gratifying to his family and most appropriate in showing an appreciation of his work. At a public meeting held in Boston on Feb. 13, a large number of gentlemen were present and it was decided that the fittest expression of gratitude for Agassiz' labors for science in this country, would be to insure the maintenance of the Museum which he worked so long and so faithfully to establish for the benefit of the country. It was agreed that at least $300,000 should be raised by subscription as a memorial fund for the purpose of endowing the Museum of Comparative Zoology in Cambridge. A large number of gentlemen, residing in various parts of the country, were named as a nucleus of a general committee for the purpose, as it was believed that the many friends to science all over the land, appreciating the worth of Agassiz, would be glad to aid in placing his Museum on a permanent basis. The feeling has been so general and of such spontaneous growth, that a memorial of this kind would be the only appropriate one for the present. We have not the least doubt but that the sum proposed will be at once obtained and we have heard that about $70,000 were subscribed the day of the meeting. Let all who respected the great naturalist, and who feel that science and education have been advanced by his efforts in their behalf, give each according to his means, and let us hope that from the many offerings of grateful hearts the memorial fund will soon be far larger than the sum named. Well knowing the immense expense of maintaining such a Museum, we trust that the Agassiz Memorial fund will not be allowed to stop at the comparatively small amount proposed.

In the reorganization of the Museum of Comparative Zoology, made necessary by the decease of Professor Agassiz, the Trustees have wisely secured the separation of the curatorship from that of the Lawrence Professorship of Zoology and Geology, and abolished the office of Director. As now organized the two executive officers of the museum are Mr. ALEXANDER AGASSIZ, *Curator*, and M. L. F. DE POURTALES, *Keeper*. Mr. Agassiz has also been elected by the Legislature to succeed his father as a trustee of the museum.

BOOKS RECEIVED.

The two Principal Groups of Urbicolæ (Hesperidæ Auct.) By Samuel H. Scudder. 8vo, pp. 2. Dec. 19, 1873.

Note on the species of Glaucopsyche from Eastern North America. By Samuel H. Scudder. 8vo, pp. 2, Dec. 26, 1873.

Bulletin of the U. S. Geological and Geographical Survey of the Territories. No. 1. 8vo, pp. 28, Washington, 1874.

Proceedings of the California Academy of Sciences. 8vo, vol. v, Pt. 2. San Francisco, Jan. 1874. Vol. 1, 1854-1857, second edition. Dec., 1873.

Notes on the Drift Soils of Minnesota. By N. H. Winchell, 8vo, pp. 8. (From Fourth Annual Report of the Commissioner of Statistics of Minnesota.) Saint Paul, 1873.

Milk: its typal relations, a lecture delivered before the Vermont Dairymen's Association. By E. Lewis Sturtevant 8vo, pp. 20. South Framingham, 1874.

Proceedings of the Boston Society of Natural History. Vol. xvi, Pt. 1. May-June, 1873, Boston.

Catalogue of the Phænogamous and Acrogenous Plants of Suffolk County, Long Island. By E. S. Miller and H. W. Young. 8vo, pp. 15. Port Jefferson, L. I., 1874.

Annals of the Lyceum of Natural History of New York. Vol. x, nos. 6-9. Mar. 1872-Feb 1873 New York.

Descriptions of new Plants from the Pacific States. 8vo, pp. 27. (From Proc. Cal. Acad. Sci., Feb. 3, 1873.)

The Birth of Chemistry. (Nature series). By G. F. Rodwell. 12mo. pp. 135. 24 Woodcuts. London, 1874. Macmillan & Co.

An Essay on the Glacial Epoch. By Philip Harvey. (Read before the Teachers' Institute of Des Moines County, Aug. 21, 1873.) 8vo, pp. 24. Burlington.

Bullettina della Societa Entomologica Italiana. 8vo, Anno Quinto, Trimestre. 1-3 Firenze, 1873.

Account of the Operations of the Great Trigonometrical Survey of India. Vol. I. The Standards of Measure and the Base-lines, also an Introductory Account of the Early Operations of the Survey during the period 1800-1830. By J. T. Walker, Superintendent of the Survey. 4to, pp. 492. Plates 33. Dehra Doon, 1870.

THE

AMERICAN NATURALIST.

Vol. VIII.—APRIL, 1874.—No. 4.

THE FLORA OF PENIKESE ISLAND.

BY PROF. D. S. JORDAN.

I GIVE here a list of the plants found on the Island of Penikese, and in the waters of Buzzard's Bay in the neighborhood of the island, during the late session of the Anderson School of Natural History. This list is probably complete in the flowering plants and measurably so as regards the higher algæ. The lichens, fungi, diatoms, etc., I have not tried to identify and they are therefore omitted.

The island as it now appears is absolutely treeless and nearly shrubless, and it is scantily covered with pasture grasses which furnish subsistence to flocks of sheep. Altogether it is about as barren looking a pile of rock and stone as one could well imagine.

When Penikese was first known it was covered with a growth of trees said to be similar to those now found on Martha's Vineyard and Naushon. Among these may be mentioned the red cedar, pitch pine, red maple, shag bark, shad, poplar birch, hornbeam and two or three species of sumach. Of this growth there is now no trace left save the rotten roots of a solitary beech stump and a few branches of red cedar and red maple (?) found buried in the muck of a small swamp.

This list may have a special interest to future students at Penikese and also a general interest to botanists, as showing which plants survive a prolonged struggle for existence against

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

grass and sheep. There are no flowering plants on the island that are at all rare, but some species very common on the mainland are conspicuously absent, for instance the asters and golden rods.

The flora of Gull, a very small island just separated from Penikese, is included. Several plants, as *Lathyrus maritimus* and *Solidago sempervirens*, are found there which are not in the flora of the main island. Probably they once grew there but have become exterminated. Such plants are marked with a star(*).

RANUNCULACEÆ.

Ranunculus cymbalaria Pursh.

CRUCIFERÆ.

Capsella Bursa-pastoris Mönch.
Sisymbrium officinale Scop.
Lepidium Virginicum L.
Brassica nigra Gray.
Brassica sinapistrum Boiss.
Cakile Americana Nutt.
Raphanus Raphanistrum L.

VIOLACEÆ.

Viola sagittata Ait.

HYPERICACEÆ.

Hypericum mutilum L.

CARYOPHYLLACEÆ.

Cerastium viscosum L.
Stellaria media Smith.
Arenaria peploides L.
Spergularia salina Presl.
Spergula arvensis L.
Sagina procumbens L.
Mollugo verticillata L.

PORTULACACEÆ.

Portulaca oleracea L.

MALVACEÆ.

Malva rotundifolia L.

GERANIACEÆ.

Oxalis stricta L.

ANACARDIACEÆ.

Rhus toxicodendron L.*

LEGUMINOSÆ.

Trifolium repens L.
Trifolium procumbens L.
Trifolium arvense L.
Lathyrus maritimus Big.*

ROSACEÆ.

Potentilla argentea L.
Fragaria Virginiana Ehrh.
Fragaria vesca L.
Rubus villosus Ait.

HALORAGEÆ.

Myriophyllum scabratum Mx.

ONAGRACEÆ.

Ludwigia palustris Ell.

UMBELLIFERÆ.

Archangelica Gmelini DC.*

COMPOSITÆ.

Erigeron Canadense L.
Solidago sempervirens L.*

Iva frutescens L.
Ambrosia artemisiæfolia L.
Achillæa millefolium L.
Maruta cotula DC.
Leucanthemum vulgare Lam.
Gnaphalium uliginosum L.
Erechthites hieracifolia Raf.
Xanthium strumarium L.
Cirsium arvense Scop.
Cirsium lanceolatum Scop.
Taraxacum Dens-Leonis Desf.

PRIMULACEÆ.

Anagallis arvensis L.

PLUMBAGINACEÆ.

Statice Limonium L.*

PLANTAGINACEÆ.

Plantago major L.
Plantago lanceolata L.

SCROPHULARIACEÆ.

Linaria Canadense Spr.
Verbascum Thapsus L.

LABIATÆ.

Teucrium Canadense L.
Lycopus Europæus L.
Nepeta cataria L.
Scutellaria galericulata L.
Leonurus cardiaca L.

CONVOLVULACEÆ.

Calystegia sepium R. Br.

SOLANACEÆ.

Solanum nigrum L.
Datura Tatula L.

ASCLEPIADACEÆ.

Asclepias incarnata var. pulchra L.

POLYGONACEÆ.

Polygonum Hydropiper L.
Polygonum Persicaria L.
Polygonum aviculare L.
Polygonum maritimum L.
Rumex obtusifolius L.
Rumex crispus L.
Rumex acetosella L.

CHENOPODIACEÆ.

Chenopodium album L.
Suæda maritima Dumort.
Salsola kali L.
Salicornia herbacea L.
Atriplex patula L.
Atriplex arenaria Nutt.

AMARANTACEÆ.

Amarantus retroflexus L.

EUPHORBIACEÆ.

Euphorbia maculata L.
Euphorbia polygonifolia L.

SALICACEÆ.

Salix discolor Muhl.

BETULACEÆ.

Betula alba var. populifolia Spach.

NAIADACEÆ.

Zostera marina L.
Ruppia maritima L.

IRIDACEÆ.

Iris versicolor L.
Sisyrinchium Bermudiana L.

JUNCACEÆ.

Juncus Gerardi Loisel.
Juncus pelocarpus Meyer.

Juncus tenuis Willd.

CYPERACEÆ.

Cyperus filiculmis Vahl.
Eleocharis palustris R.Br.
Eleocharis acicularis R.Br.
Scirpus pungens Vahl.
Scirpus maritimus L.
Carex scoparia Schk.
Carex straminea Schk.

GRAMINEÆ.

Agrostis alba L.
Agrostis vulgaris With.
Phleum pratense L.
Setaria viridis Beauv.
Setaria glauca Beauv.
Anthoxanthum odoratum L.
Festuca ovina L.
Festuca elatior L.
Poa annua L.
Poa pratensis L.
Poa serotina Ehrh.
Glyceria maritima Wahl.
Spartina juncea Willd.
Spartina stricta Roth.
Calamagrostis arenaria Roth.
Triticum repens L.
Holcus lanatus L.
Panicum sanguinale L.
Panicum dichotomum L.
Panicum crus-Galli L.
Elymus Virginicus L.*

FILICES.

Dicksonia punctilobula Kunze.

MUSCI.

Polytrichum commune.
Ornithotrichium (undetermined).
Undetermined.

MELANOSPERMEÆ (Olive-green Algæ).

Sargassum vulgare Agardh.
Sargassum Montaguei Bailey.
Fucus nodosus L.
Fucus vesciculosus L.
Desmarestia viridis Lam.
Laminaria saccharina Lam.
Laminaria digitata Lam.
Laminaria ascia Ag.
Laminaria longicornis Pylaie.
Dictyosiphon fœniculaceus Grev.
Punctaria tenuissima Grev.
Asperococcus echinatus Grev.
Chordaria flagelliformis Ag.
Chordaria divaricata Ag.
Lathesia tuberiformis Gray.
Elachista fucicola Fries.
Sphacelaria cirrhosa Ag.
Ectocarpus littoralis Lyngbye.
Ectocarpus siliculosus Lyngb.

RHODOSPERMEÆ (Red Algæ).

Rhodomela subfusca Ag.
Polysiphonia formosa Sahr.
Polysiphonia subtilissima Mont.
Polysiphonia Olneyi Harv.
Polysiphonia Harveyi.
Polysiphonia elongata Grev.
Polysiphonia violacea Grev.
Polysiphonia variegata Ag.
Polysiphonia nigrescens Grev.
Polysiphonia affinis.
Polysiphonia fastigiata Grev.
Dasya elegans Ag.
Champia parvula Harvey.
Corallina officinalis L.
Nullipora polyphyllamca ?
Grinnellia Americana Harv.
Delesseria sinuosa Lam.
Gelidium corneum Lam.
Polyides rotundus Grev.
Rhodymenia palmata Grev.
Furcellaria fastigiata ?
Phyllophora Brodiæi Ag.
Ahnfeltia plicata Fries.
Cystoclonium purpurascens Kützing.
Chondrus crispus Lyngb.
Spyridia filamentosa Harv.
  var. refracta Harv.
Ceramium rubrum Ag.
Ceramium diaphanum Roth.
Ceramium fastigiatum Harv.
Ceramium arachnoideum Ag.
Ptilota elegans Bonnemaison.
Griffithsia corallina Ag.
Callithamnion Baileyi Harv.
Callithamnion Borreri Ag.
Callithamnion byssoideum Arn.
Callithamnion corymbosum Ag.
Callithamnion seirospermum Griff.
Callithamnion plumula Lyngb. (rare).
Callithamnion Americanum Harv.

Callithamnion Turneri Ag.
Callithamnion Daviesii Ag.
Callithamnion luxurians Ag.

CHLOROSPERMEÆ (Grass-green Algæ).

Bryopsis plumosa Lam.
Vaucheria (species not described by Harvey, allied to V. Murina).
Porphyra vulgaris Ag.
Bangia fuscopurpurea Lyngb.
Enteromorpha intestinalis Linb.
Enteromorpha Hopkirkii M'Calla.
Enteromorpha compressa Grev.
Enteromorpha clathrata Grev.
Ulva latissima L.
Cladophora arcta Dillw.
Cladophora lanosa Roth.
Cladophora glaucesceus Griff.
Cladophora flexuosa Griff.
Cladophora albida Huds.
Cladophora gracilis Griff.
Cladophora fracta Fl. Danica.
Chætomorpha melagonium Web. and Michr.
Chætomorpha ærea Dillw.
Chætomorpha Olneyi Harvey.
Hormotrichum Younganum Dillw.
Calothrix confervicola. —
Calothrix scopulorum. —

ON LOCAL VARIATIONS IN THE NOTES AND NESTING HABITS OF BIRDS.

BY ROBERT RIDGWAY.

MR. ALLEN has called attention to the variation in the notes of different birds at remote localities; and in this I am able to corroborate him, though I think that cases of such variation are very rare, and do not occur in more than perhaps five per cent. of the species. I have only detected it in two or three species after the most careful observation, and in very many cases noticed that there was not, in the minutest particular, any difference between individuals of one species on opposite sides of the continent. Such is undoubtedly the case in a very great majority of the species, any seeming variation that may be observed being more probably the peculiarity of an individual rather than the manifestation of any regional impress. The only instances wherein I have yet been able to satisfy myself of a difference in notes in two regions are the following; *Cardinalis Virginianus* has a far finer song in southern Illinois than it has in Maryland, the notes being not only clearer and more musical, but the song more continued and energetic; the effect being altogether richer. In the vicinity of Washington, D. C., I have never heard, in a single instance, the Baltimore oriole (*Icterus Baltimore*) utter such mellow, flute-like notes, as it habitually does in southern Illinois. The brown thrasher (*Harporhynchus rufus*) also sings more vigorously in the latter locality. In the far west I found the ground robins of the Wahsatch Mountains (*Pipilo* "*megalonyx*") to have such different notes from those of the eastern slope of the Sierra Nevada (in the neighborhood of Carson City) that it seemed that they must certainly be a different species; not only did the song differ, but all the notes were different. Yet upon the closest comparison of the specimens, no tangible differences in plumage or proportions could be detected in the majority of the specimens from the two localities, though occasional individuals from the latter place inclined, more or less, toward the form known as *P. Oregonus.*

The exact nature of the difference in notes between certain birds in the Potomac valley, and the valley of the lower Wabash, is a very marked *restraint* in the songs of the former, *as if they were afraid of being heard.* That they were more cautious in the neighborhood of noisy cities, than in the country surrounding quiet and less populous towns, might be readily suggested as the solution of this difference, were it not for the fact that other species, as, for instance, the robin (*Turdus migratorius*), the meadow lark (*Sturnella magna*), the catbird (*Galeoscoptes Carolinensis*), the *Thryothorus Ludovicianus* and numerous other species, sing as boldly and in a precisely similar way among the parks and shade trees in the midst of Washington City as they do in the quiet towns and retired orchards of southern Illinois. This objection may lose weight, however, when we consider that the species in which I have noticed a difference are birds of a suspicious and cautious nature, such as would be most readily influenced by the causes mentioned.

Mr. Allen has called attention* to variations in the mode of nesting, which he has noticed in many species of birds; and places undue importance upon it in considering certain deviations from the usual manner as characteristic of particular localities. My experience has been that such variations depend mainly upon the facilities afforded by the site of the location of the nest, and sometimes, no doubt, are the result of merely the caprice of the bird. The *Quiscalus purpureus* is cited as one example, and considerable stress is laid upon the fact of its placing the nest in cavities of trees in a certain locality in New England. At Mt.

---

*See AMERICAN NATURALIST, vol. vi, p. 263.

Carmel, Illinois, where this species is very abundant, I have found its nests situated in a variety of ways upon one tree; some being saddled upon the branches, or supported in a crotch like those of the robin, and others placed in cavities, either natural ones such as knotholes or decayed places, or in the holes made by the larger woodpeckers (*Hylotomus* and *Colaptes*). I once found a very large colony of these birds breeding upon a small island in the Wabash River. The nests were all placed in the tall slender willows, none more than twenty feet from the ground, and many within easy reach without climbing; they were supported by small twigs *against the body of the saplings*, for there were no large limbs to support them. Probably more than a hundred pairs were nesting in this community, as upwards of seventy nests were found in a short time. Within the area of a square mile, I have found nests of the common dove (*Zenaidura Carolinensis*) upon trees, on the top of stumps in the thick woods, on the flat rail of a fence, and upon the ground in grain fields; also nests of *Harporhynchus rufus* in as diverse situations. Near Mt. Carmel the white-bellied swallow (*Tachycineta bicolor*) nests exclusively in holes made by the downy woodpecker (*Picus pubescens*) and chickadee (*Parus Carolinensis*), in the dead, stumps around lagoons in the bottom lands, in company with the golden swamp warbler (*Protonotaria citrea*), with which it shares these cavities. At Carson City, Nevada, this species was noticed to nest only about houses, in the eaves or over porches, as the purple martin (*Progne subis*) does in the east. There were no trees there to accommodate them, which accounted for this deviation from their original habit. At Mt. Carmel, the purple martin and chimney swift (*Chætura pelagica*) have almost entirely forsaken these nesting places, and have taken up with man; the former being as domestic as house pigeons, and the latter possessing themselves of the chimneys. But the white-bellied swallow pertinaciously clings to its primitive custom. In California, according to various writers, and in Arizona according to Dr. Coues, the *T. thalassina* nests in holes in trees, but during two years of collecting in Nevada and Utah I never saw a nest of this species so situated; it constantly nested in horizontal fissures or crevices on the face of the limestone cliffs, in company with the "mud swallow" (*Petrochelidon lunifrons*) and white throated swift (*Panyptila melanoleuca*). This was apparently not owing to a lack of suitable places for nesting as it does in California and Arizona, for in the same localities were extensive aspen woods where *T. bicolor* and *P. subis* nested abundantly in holes made by the *Sphyrapicus nuchalis.* The inference drawn from this fact is, that it has a natural preference to rocks as a nesting place, always ignores the trees where suitable rocks are to be found; and that its nesting in trees in districts where precipices are rare or wanting is merely an evidence that it, like other species, adapts its habits to the character of the locality. The red-fronted linnet (*Carpodacus frontalis*) nests about houses in California; choosing nooks and crannies about the buildings, as well as the shade trees, for nesting places. At Sacramento I found a nest of this species built inside the pendulous, basket-like structure of the oriole (*Icterus Bullocki*). Along the Truckee River, in Nevada, another was found inside the mud nest of a cliff swallow (*P. lunifrons*); around Pyramid Lake the species nested among the rocks, frequently in caves with the *Sayornis Sayus* and *Hirundo horreorum;* while in the wooded portions of the Truckee valley its nests were common in the "grease wood" (*Obione*) bushes, along with those of *Spizella Breweri* and *Poöspiza bilineata*, as well as in the cottonwood trees near by. It would require too much space to describe all the different situations in which I have found the nests of *Troglodytes Parkmanni*, so that I will only mention some of the more remarkable instances of variation. In the Wahsatch Mountains, as well as in the Truckee valley, it was usual for the nests to be concealed behind the loose bark of a dead tree, the entrance being through a fissure in the bark at one side of the nest; probably eight out of every ten nests would be so situated. Many, however, were found inside of cavities, either natural or made by woodpeckers, while one was found built inside of a deserted robin's nest in the crotch of an aspen.

On the Truckee reservation one was found in the thatched roof of the storehouse. Everywhere, throughout the mountain of the great basin, the sparrow hawk (*Tinnunculus sparverius*) nests on the cliffs, in holes among the rocks, in company with the *Falco polyagrus.* At Mt. Carmel, I have found nests of *Colaptes auratus* in natural cavities in trees, and a nest of *Centurus Carolinus* in a low stump by the roadside, about three feet from the ground. At the same place, *Parus Carolinensis* bores its own nesting place in the soft wood of wild plum and sassafras trees, and frequently takes possession of natural hollows in stumps, uprooted "snags," or the deserted excavation of the downy woodpecker. I found a nest of the chimney swallow inside of a plank kiln for drying tobacco, and another inside of the hollow trunk of a sycamore tree. At Olney, I found a nest of the blue jay, containing five eggs, inside of an old deserted barn in the middle of the town, it being placed flat upon a sill. This is the only nest of the species I ever saw that was not placed in a tree. At Mt. Carmel, I have also found a nest of *Agelaius phœniceus*, containing eggs, in a small elm tree about twenty feet from the ground. In Kansas the *Euspiza Americana* is said to place its nest in trees; but at Mt. Carmel it habitually places it on the ground in clover fields. The *Chondestes grammaca* almost invariably nests on the ground in the Wabash valley. I have never found a nest otherwise located; but at Sacramento, where dozens of nests of this bird were found, all but one were in oak trees, at heights varying from ten to thirty feet from the ground. It is difficult to understand why the species should be so much more arboreal in the vicinity of Sacramento, which is far more scantily wooded than the localities frequented by this bird in Wabash valley. An instance of semi-parasitic habits is seen in the *Otus Wilsonianus*, which in Nevada habitually deposits its eggs in the old dilapidated nests of magpies.

During a series of several seasons' egg-collecting at Mt. Carmel, it was my constant experience to find several species of birds never laying more than three eggs at a complement; and the recorded accounts of these species in various works saying that the same birds laid habitually four or five eggs puzzled me considerably. Three eggs in a nest is the maximum number that I have ever found in *Pyranga æstiva* and *Cardinalis Virginianus*.

A NEW SPECIES OF WILLOW FROM CALIFORNIA, AND NOTES ON SOME OTHER NORTH AMERICAN SPECIES.

BY M. S. BEBB.

SALIX LÆVIGATA, n. sp. Very glabrous, except the scales and rachis of the catkin, and a few small caducous silky leaves at the base of the shoots; leaves elliptic-ovate or broadly lanceolate, pointed, finely serrulate, but the margin revolute and thus appearing entire, coriaceous, dark bluish green, glossy and prominently nerved above, paler beneath; stipules small, ovate, caducous; petioles short (1″–4″ long) not glandular; catkins cylindrical, 2 or 3 inches long in flower, the fertile becoming loose in fruit, always borne on short lateral leafy branches; scales erose-dentate at the apex, distinctly nerved, hairy at the base and on the inner surface; ♂ obovate, rounded and more evenly dentate, ♀ narrower, truncate with a few irregular teeth, caducous (in outline, when magnified, like the leaves of *Potentilla tridentata*); ovary globose-conical, smooth, long stalked (as in *S. amygdaloides*); stigmas sessile, 2-lobed; stamens 3–5.—California, at Santa Cruz, Dr. C. L. Andersson, to whom I am indebted for a very interesting collection of California Salices. Ukiah, Kellogg and Harford, No. 921. Alameda Co., Bolander, in herb. A. Gray.

A remarkable species of the Amygdalinæ group, distinguishable from all forms of *S. nigra* Marsh. (the only near ally in the U. S.) by the conspicuous dentate scale, and very different foliage. *S. lasiandra* Benth., a western modification of *S. lucida*, has an obscurely dentate scale, but is otherwise very unlike. As the buds expand, two or three small scale-like leaves appear clothed beneath and fringed on the margin with ferruginous silky hairs; these soon fall off; the lowest persistent leaves on the branches are obovate, obtuse with an abrupt point, almost sessile; these are followed by others broader, more pointed, on short petioles, passing into the lanceolate taper-pointed form of the fully developed foliage.

S. PYRIFOLIA Andersson. This elegant species, recorded by Andersson from the Lake Winnipeg and Saskatchewan region, was sent me by the Rev. Jas. Fowler from New Brunswick, and from within our own limits by Dr. Clarke from Flint, Mich.; two widely sundered stations on our northern boundary, suggesting the possible occurrence of intermediate ones. The only additional specimens in Prof. Gray's herbarium are two ♂ fragments named by Andersson, enough to confirm the correctness of the above determination. The typical form has round, sub-cordate, very thin, reticulate veined leaves, slender petioles, small caducous stipules, foliaceous peduncles, and very long and slender pedicels. The var. *obscura* (apparently a more vigorous growth of the same plant?) would be likely to escape observation from its general resemblance to some forms of *S. cordata.*

S. ADENOPHYLLA Hook. This is another and most interesting addition to our willows of the Northern States. Its occurrence on sandy beaches of the Great Lakes I have already noticed in "The Lens."

S. CUTLERI Tuck. If Dr. Andersson's var. *Labradorica* (DC. Prodr. xvi, p. 292) is rightly associated with our White Mountain plant, then the old name of *Uva-Ursi* Pursh ought to be restored for the Labrador plant, and ours become its var. *Cutleri.*

Col. S. T. Olney observes that *S. tristis* Ait. flowers "fully a fortnight later than *S. humilis.*" This is noteworthy, as *S. tristis* affects warm, sunny knolls, and would therefore be expected to flower *earlier* instead of later than its more robust congener, *S. tristis* var. *microphylla.* For all I know this variety rests upon a single gathering, distributed by Mr. Oakes many years ago; probably a *forma monstrosa.* I had in my garden last summer precisely the same "rigid and contorted" leaves produced on *S. viminalis* by insects infesting the under surface, but have looked in vain over acres of *S. tristis* for specimens to match those of Mr. Oakes.

THE ROBIN.

BY CAROLINE BOYCE.

THE American robin (*Turdus migratorius*) is too well known to every resident of the United States, to require any extended description, and yet, I am often surprised at the ignorance of farmers and countrymen in general, as to his character and habits. They shoot and stone, and destroy and berate, but never praise him; still he perseveres, in the very teeth of an adverse fate, and comes regularly with the spring months, appearing sometimes, in clement seasons, in eastern New York, in February, and remaining oftentimes when the fall is favorable until late in November, and instances have been known when a straggler separated from the main flock has remained, and survived the severity of a winter in latitude 42° north, in a locality where evergreens were prevalent. The robin can accommodate himself to a variety of food, and during the summer season is the farmer's best friend. He is hardy and robust and brave, one of our valuable, but most badly abused birds. His food is mainly insectivorous, from the time he comes amongst us until late in the autumn. He makes occasional visits to the cherry tree but does not depend on it for a subsistence as he is supposed to do. He pecks at the cherries because they are red, just as he would pick to pieces a red flower. The species appears fond of the color. In the fall they feed largely on wild berries, and are slaughtered by the thousands by sportsmen along the lines of the Hudson, in the cedar thickets, which they frequent, feeding on the berries, on the islands in the harbor of New York Bay, and in New Jersey. I am too much the friend of this bird to be blind to his petty faults, for petty indeed they must remain so long as his increase is kept in rigid restriction by his many enemies. The crow (*Corvus Americanus*) commits fearful and cruel depredations on the robin and his belongings. The species is a bitter foe to all smaller birds, and keeps them in severe check, but the robin suffers numerous outrages from other hands, and the elements sometimes play him a mischievous trick. Not only the crow, but the crow blackbird (*Quiscalus versicolor*) and the cuckoo (*Coccygus Americanus*) often rob the nest after the eggs are laid, and thus all the female's labor proves in vain. The robin will steal into the nest of one of her own kind, during a temporary absence of the owner, when she had thus been robbed, and appropriate it as her own, depositing a remaining egg of her clutch, or mayhap more and, if plucky, will drive off the legal owner, and taking bold possession, bestow all her care thereon, but she never disturbs the rights of other birds. Occasionally she only drops an egg into a sister's nest when taken short, her own being destroyed, but the act is never deliberate or voluntary, a habit that is never practised among the species except in extreme cases of necessity, for regular bird life has its laws that are observed, and crimes and persecutions are often punished. The nest, which is an extravagant, clumsy affair, extravagant as to material employed, is patted up by the feet at the fork of limbs, and is moulded in the inside by the breast, the bird turning round and round many times with the tail hugged down close on the outer rim, the female performing all the labor. The male takes no part in this structure, but is stationed near as a guard, and gives the alarm if danger portends, while the *mater en famille* is absent in quest of material. If all be quiet and serene, a snatch of song may greet the listening ear, but it is hurried, for the male is deeply interested in operations, and feels a heavy responsibility resting on his shoulders. When the female is descried with a supply in her beak, he immediately flies to meet and accompany her. The two alight near and survey the premises when, if all be right, the labor goes on vigorously. This work occupies them three or four days, sometimes a shorter period, according to the urging necessity of nature that the bird feels. The eggs are deposited daily, until the number is dropped. The robin on an average lays four eggs, but I have seen five eggs, followed by five birds in one nest, all one mother's progeny, but there are oftener three. Two appears to be the lucky number for the robin, and they usually go mated from the nest. A robin lodged her nest in a small tree near my dwelling last year in the after part of May, and reared three young. When they were able to leave the nest, another was built a little farther off in the fork of a young pear tree, not more than five feet from the ground. In this nest was brought up, right under the loaded boughs of a cherry tree, two fine birds, a male and a female, and all my sedulous watching never caught them in the guilty act of carrying cherries to the nest. The birds had become accustomed to me, and familiar, and never appeared to stand in fear of my scrutinizing presence, although they eyed my movements as closely as I viewed theirs; but I always observed a formal distance, and held in respect their individual rights: thus was I tolerated without giving disturbance. The robin rears but two broods in one season. After the first brood leaves the nest, in a day or two, they are turned over entirely to the charge of the male, who feeds, protects, and keeps in close proximity, while the female is occupied with preparations for a second family. The second nest is not very far removed from the first, and fortunate indeed must the parents be if these two broods all grow to be adult birds. If the male gives no assistance in building the nest, yet he has his duties to perform which become him marvellously. As soon as the birds are out of the shell it is his business to clear out the nest of all offensive matter, and keep it clean of all excrement until the birds have flown, provide all the food, which is purely insectivorous, and sit upon the nest in the female's absence, which is no small ignoble office for so brave and noble a fellow as cock robin. He finds but little time now for his loud, long strains. His part of duty will not bear neglect.

The young, when left undisturbed, seldom go far away from the home nest, although when they once leave, they never enter it again. It is left in an uncleanly state, generally alive with vermin, which soon leave the young bird. The robin is remarkably clean in every habit, and takes a daily bath. I was much amused one day, the past summer, at a little incident that occurred in the front yard under the cherry tree.

A female robin was gathering materials for a second nest, picking from around the roots of rose bushes, the long dead grasses, until her beak was filled and the ends flowed out like silken hairs, when suddenly one of her own young ones, a pretty mottled little creature, alighted in front of her and, opening wide her yellow throat, begged for food. The mother thus taken without warning was confused, and administered a gentle peck on the head as a reproof, which did not have the desired effect, so she immediately plunged the whole contents of her beak down the little one's throat and flew away. The poor little thing had a long and difficult tug, in clearing its throat of the unstable commodity, but the repentant parent soon returned with wholesome food, and gave her offspring, after which the male appeared, and piloted off the offending charge to an adjoining tree. No doubt mine frau gave her liege lord a severe curtain lecture, upon the occasion. Secrets of bird-life are seldom revealed but to the understanding few. Has any one ever observed the manner in which a bird approaches its object, how cautiously, politely, quietly, it proceeds moving with one eye ever on the alert for danger, and the other solicitously bent on the particular thing of its desire? How it advances, then recedes, then bows and courtesies with all the suavity of a Frenchman, and peers inquiringly, stooping down low, placing its nimble little body in a thousand graceful positions, as it slowly, steadily and discreetly approaches its object of concern?

If I should venture to say that not a cherry would grow, fit to be eaten, were it not for the birds, the bare idea would be hooted as preposterous, yet such nevertheless is my belief. Were it possible to remove all the birds out of the way, for one season at least, what a decided difference would our future orchards present! Where now are thrifty growths, beautiful leafage, and large crops of fair fruit, would be seen stinted, moss-grown limbs with sparse or meagre foliage, crops of dwarfed specimens, that have finished their growing, in a knotty, wormy, inferior state. The majority of all the large families of insects are bred in the earth, and go through various forms in different stages of existence and are devoured by birds of every description, chief among which stands our friend, the robin.

The robin sits eleven days. On the eleventh the young are out of the shell, and on the eighth their eyes are wide open and bodies covered with pin feathers. In eleven days more they leave the nest on an average, although when the nest be not crowded they remain two days longer. Upon close observation the plumage of the adult robin is tame, but rich and mellow, with soft colorings. The top of the head is dappled in brown and black, with delicate markings and pencillings at the throat where it meets the cinnamon breast in the male. The female is lighter in color and has no rosy tinge to the neck feathers. There is but a slight difference in the size of the male and female, but the general shape and build of the birds is marked so perceptibly that a practised eye can readily distinguish between the two. In general appearance the female is the larger bird, but the male is stronger, closer and altogether more powerful in limb. The large bright eyes in both sexes are set in a ring of white. As a songster, the robin does not rank high, yet there are some rare singers among the species. A singer has a long, slender body, a long neck, long tail, dark, rich plumage, soft like satin. He is a fine bred bird. All are not first class singers. Nature does not appear to endow all with her rare gift. Where there is one that is a singer there are scores that are only mediocre. The robin's note is peculiarly mellow and flute like, sometimes a little irregular and extravagant, but, when followed closely, through all its various changes, vibrations and intonations, is found to possess a striking sweetness and freshness, seldom excelled and rarely equalled, if we except the beautiful strain of the hermit thrush. He gives to his lower notes a quiet dash of subdued sadness, and then immediately swells them to upward bars of wondrous perfection and beauty. He has a set of notes in an under key that are seldom heard by the unobservant ear, and if heard are attributed to another bird. He gives a clear, quick, military call and has a piercing cry of distress. The notes about the nest are all suppressed and low, but yet clear and distinct. They are uttered by the female and are the language of the mother to her offspring. She has no distinct song.

RAMBLES OF A BOTANIST IN WYOMING TERRITORY.

BY REV. E. L. GREENE.

NO. II.

With the month of July, the varied profusion of flowers begins to be greatly reduced on the high plains, whose rich spring flora was briefly sketched in the last number.

On the third of this month we stood upon the summit of a ridge commanding a view of many surrounding miles of these treeless lands. The grasses, under the constant sun and the now advancing drought, were already losing their freshness of color, and becoming cured, uncut, into hay for the antelope and the domestic herd, to feed them during the next eight months. There is yet one very showy flowering plant, which has so far resisted the drought, and is now giving to even hundreds of acres of ground the very azure of the sky above — a sea of blue. The plant is *Delphinium azureum* Michx., a perennial species of larkspur. In the month of April the root-leaves make their appearance, and as they furnish then the only sort of green herbage that has been seen for many months, herdsmen are obliged to exercise all diligence to keep cattle away from the tracts which this plant occupies. The leaves when eaten cause speedy death, and so this great beauty of the plains is known to the settlers by the name of "poison weed."

On the stony ridge, our point of observation, there was not much left at this season to interest us, save the fruits of the Astragali and other remains of the flowers of spring. A little daisy-like composite, with white rays, quite stemless and altogether unnoticeable but for the comparatively large size of its flowers, was new to us then, and a good acquisition, proving to be Nuttall's *Townsendia strigosa*. Another tenant of this same series of hills now in flower is *Eritrichium glomeratum* DC., a coarse hairy biennial a foot high, belonging to the natural order Borraginaceæ. Along the dry margin of what had been a pond at an earlier date, we found an abundance of a very small Gilia (*G. minima* Gray) which, as we have never seen it anywhere else, in all the region, must be accounted as rare in these parts, as it is minute and interesting. *Gilia congesta* Hook., a handsome species, is now to be found in a good state for collecting, growing in the gravel beds along Crow Creek, at Cheyenne, and with it the splendid blue-flowered *Pentstemon glaber* Pursh.

The railway station, Sherman, some thirty or thirty-five miles west from Cheyenne, has an altitude of about two thousand feet above that of Cheyenne, and the flora of that vicinity is still more interesting than that of the region we have just been noticing, especially at this season of the year. It was on the 3d of July that we had a delightful ramble among the rocky "Black Hills," in this part of the Territory. Although this district does not suffer from drought as do the lower altitudes, yet timber appears always to have been scarce. One can see that whatever was available for the purposes of fuel and ties for the railway has long since been appropriated, and there now remain only a few scattered pines (*Pinus ponderosa* Dougl.) on the hills, and some little groves of aspen (*Populus tremuloides* Mx.) in the moist valleys. There are straggling bushes of "wild sage" (*Artemisia tridentata* Nutt.) growing on all the hilly portions of the land, and with it we found the more interesting *Purshia tridentata* DC., a rosaceous shrub, with inconspicuous flowers, easily mistaken for sage brush itself. *Salix rostrata* Rich., *S. glauca* L., and one or two other species of willow, were noticed in some boggy places, their leaves in the early morning drooping and distorted, as were also those of the herbaceous plants, with the severity of the night's frost, even in early July.

On dry open grounds we found an abundance of *Castilleia parviflora* Bong., a fine scarlet-flowered species peculiar to the far west, and with it a more strictly alpine, and a yellow-flowered one, *C. breviflora* Gray. These two, together with plenty of that most handsome Pentstemon, *P. acuminatus* Dougl., were enough to convert even the otherwise barren hillsides into a paradise of beauty. Among the grasses and sedges of the marshy places, were quantities of a large "buttercup," an unusually showy form of *Ranunculus affinis* R. Br.; and also an Allium, species uncertain, for we indulged a natural dislike for the whole tribe of leeks, and passed by these really handsome purple-flowered ones without taking one specimen for our herbarium. A fine "monkshood" (*Aconitum nasutum* Fisch.), its flowers in most cases dark purple, but in other specimens yellowish-white, was also very conspicuous in wet shades; and in the edges of these wet places, grew *Hedysarum boreale* Nutt. and *Astragalus alpinus* L.; both interesting leguminous plants not often met with.

One crystal brooklet had its margins adorned with the large yellow purple-dotted corollas of *Mimulus luteus* L., while the damp ground near by was neatly carpeted with *Veronica serpyllifolia* L. These two elegant Scrophulariaceæ, one belonging eastward and the other more exclusively to the distant west, have met here on common ground; and with them was a very diffuse Androsace, with pale foliage, the species doubtful.

Out again upon higher and drier land we suddenly came upon quite an unexpected rarity in *Ranunculus Nuttallii* Gray. We had found it twice in Colorado, in shaded ravines, in the original slender form: but this Wyoming plant has far more numerous and more showy flowers than before seen. It is quite abundant, too, in this new locality. Here was an abundance also of *Eriogonum umbellatum* Torr., with that cream-colored shade of flowers usually met with in this plant at higher altitudes. They are always of a deep, rather greenish yellow in the less elevated localities. Under the shade of some high and massive piles of rock, which constitute an interesting feature of the landscape at this place, we found for the first time, in all our Rocky Mountain rambles, the splendid *Polemonium confertum* Gray. It was the larger variety, and all the flowers pure white. This alone, we then thought well worth our thirty miles' journey on horseback; but a few weeks later, the discoverer of the plant conducted us to one of his original localities of it, near the summit of Parry's Peak in Colorado.

At the margin of a shallow pond, walled in on one side by rocks, and hidden on the other by a growth of aspens, we frightened, from his herborizing among the sedges, a fine black-tailed deer and gathered for ourselves some large specimens of the brilliant *Pedicularis Grœnlandica* Retz, and the large silvery leaves of the rare *Nardosmia sagittata* Hook. But the day was now past the meridian, and we were obliged to take leave of this interesting ground, in order to reach Cheyenne at a reasonable hour of the evening, gathering by the way, upon the lower plains, the vespertine Mentzelias and Œnotheras, which unfold their petals towards sunset, and breathe fragrance upon the air of night.

BOTANICAL OBSERVATIONS IN WESTERN WYOMING.

BY DR. C. C. PARRY.

NO. IV.—APPENDIX; DESCRIPTIONS OF NEW SPECIES, ETC.

THE numbers are those affixed to the tickets in the distributed collection, and referred to in the preceding articles. The characters or descriptions which follow are by the botanists respectively whose names are appended to their several contributions, — in which the collector, having been summoned to a remote frontier, is able to take only a small part.

3. **AQUILEGIA JONESII.**—Acaulescent, minutely soft-pubescent; leaves all crowded, and the persistent scale-like dilated bases of their petioles imbricated on the stout ascending branches of the rootstock, biternately divided; the primary divisions with very short if any partial petioles, and the secondary ones sessile or confluent at base, so that the nine small and obovate entire leaflets or divisions are in a dense cluster; scape from one to at length three inches high, naked, exceeding the leaves, one-flowered, sepals and petals blue; the former oblong, exceeding the gradually tapering straightish spurs; styles long, exserted; pods turgid, reticulated, smooth.—In crevices of loose arenaceous limestone, on the summit of Phlox Mountain, forming close clusters. A remarkable and most distinct, very dwarf species, collected July 18, mostly out of flower, and with full-grown fruit; but a few blossoms were secured. The species is dedicated to Capt. W. A. Jones, U. S. Engineer, who first detected this interesting species, and to whose efficient aid as Commander of the expedition the botanical collection is largely indebted for its most valuable results.—C. C. PARRY.

13. **STANLEYA TOMENTOSA.**—Very stout, white-villous or hirsute throughout (especially the foliage and lower part of the stem); radical and lower leaves lyrate-pinnatifid in the manner of *S. pinnatifida*, the upper ones entire and hastate, passing into lanceolate and finally into subulate bracts for the lower flowers; raceme very dense and thick, cylindrical (becoming a foot or a foot and a half long), of almost innumerable pale cream-colored flowers; pedicels in fruit about the length of the filiform stipe.—Owl Creek on dry slopes in gypseous soil. Biennial, perhaps sometimes perennial by offshoots, one to three feet high. Petals lanceolate, oblong, narrowest in the centre. Stigma green.—C. C. PARRY.

DRABA VENTOSA.—Depressed and cæspitose, branching from slender rootstocks, canescently tomentose throughout, the pubescence stellate; leaves crowded on the mostly tufted branches, spatulate oblong or obovate, entire, not rigid; peduncle in fruit exserted beyond the leaves, corymbosely 3–5-flowered; petals golden yellow; silicle oval or orbicular, tomentulose-hirsute, tipped with a short distinct style.—On a high rocky peak overlooking Snake and Wind River valleys. The larger and laxer leafy shoots are an inch and a half or more in height; the denser shorter and in a close tuft. Leaves 3 to 5 or even 6 lines long, of soft and herbaceous texture, obtuse and pointless, tapering to the base; the pubescence wholly soft and stellate, the stellular tuft generally slender-stipitate. Scape or peduncle half an inch to nearly an inch in length when fully developed. Petals obovate or spatulate, 2 lines long. Silicle fully 2 lines wide, 2½ to 3½ lines long; the abrupt style half a line to nearly a line long. The foliage is not unlike that of the imperfectly known *D. eurycarpa* Gray, of the Sierra Nevada.—A. GRAY.

65. **ASTRAGALUS (ONOBRYCHOIDES) VENTORUM** Gray MS.—Somewhat canescent with short appressed hairs; the stems from a subterraneous perennial rootstock, erect, 4–6 inches high, flexuous, simple; stipules large and scarious, free from the petiole, united and amplexicaul; leaflets 4–8 pairs, broadly obovate, 4–6 lines long, rounded or retuse at the apex; racemes loose, short peduncled, equalling the leaves; flowers 5–6 lines long, light yellow, the tubular-campanulate calyx 3 lines long, with short setaceously tipped teeth; legume sessile, slightly pubescent, turgid, oblong, 6–9 lines long, slightly curved, completely 2-celled, the ventral suture somewhat prominent and the dorsal slightly impressed.—Collected on Wind River; differing from the other species of the section in its habit, which is that of *A. succumbens*, in its yellowish flowers and larger legumes.—S. WATSON.

75*a*. **ASTRAGALUS (PECTINATI) GRAYI** Parry MS.—Distinguished from *A. pectinatus* by the broader leaflets, which are 1–1½ inches long by 1½–2½ lines broad, quite strongly veined, and by the somewhat thinner pod, ascending instead of deflexed. The flowers are "light yellow."—On the gravelly ridges bordering Owl Creek valley.—S. WATSON.

126. **ASTER (ORTHOMERIS) PARRYI.**—A span high, hoary, with a thin loose tomentum; stems several from a rather woody rootstock, simple, the naked peduncle-like summit bearing a single large head; leaves spatulate, cuspidate; scales of the involucre in two series, oblong-lanceolate, very much acuminate, cinereous-pubescent; rays numerous, white, over half an inch in length; akenes very white-villous.—A. GRAY.

144. **TOWNSENDIA PARRYI.**—Perennial, canescently pubescent; the caudex very short; leaves rosulate, obovate-spatulate, often apiculate, tapering into a petiole of about an inch in length; peduncles stout (2–4 inches long), solitary or several, somewhat leaf-bearing below, naked above and bearing single large heads; scales of the involucre in 3 or 4 series, lanceolate, acute, herbaceous, with scarious lacerate-ciliate margins, the inner ones acuminate; rays bright blue, double the length of the involucre; pappus the same in rays and disk, persistent, of stout and unequal barbellate bristles, a little longer than the akenes.—In the Wind River Range at 9,000 feet alt. (referred to as *T. scapigera* on p. 13). This very beautiful daisy is closely related to *T. scapigera*, and has much the same foliage and a similar pappus and achenium, but the heads are fully as large as those of *T. grandiflora* (1½ to 2 inches broad), are supported on very stout stalks, and have the rays bright blue. The involucral scales are more pointed than in *T. scapigera*, and the leaves are usually apiculated, as they are not in the latter.

With very fine specimens of the above. Dr. Parry has also collected *T. spathulata* Nutt. (Nos. 142 and 145), and a single plant of a very different species which he proposes to call

T. CONDENSATA (no number. See p. 106). — It has a proper caudex two inches long, marked with the scars of former leaves, and at the top bears a dense mass of small, oblong-spatulate, white-hairy leaves, and, buried among them, a single sessile head rather larger than that of *T. sericea*. The involucre is composed of numerous very narrow acuminate scales, which are lacerate-ciliate along the scarious margin. The pappus consists of rather long barbellate bristles, that of the (infertile?) rays similar but scantier. The rays are pale pink, and about eight lines long, and the disk-florets exceedingly numerous. Not having seen a specimen of Nuttall's *T. incana*, I have some doubt as to whether this may not be his plant of that name. If not, it may properly bear the name which Dr. Parry has proposed. It grew on a high peak in northwestern Wyoming. — D. C. EATON.

154. APLOPAPPUS (STENOTUS) MULTICAULIS.—*Stenotus multicaulis* Nutt., Torr. and Gray, Flora. Wind River.—An interesting rediscovery of this species, which seems to hold truly distinct from *A. acaulis*, which is also in the collection (157).—A. GRAY.

150. SCHKUHRIA INTEGRIFOLIA.—Hoary-puberulent, becoming glabrate; scapiform flowering stems a span high from a branching caudex, leafy only at base, bearing one to four or five loosely corymbose heads; leaves alternate, thickish and coriaceous, oval or sometimes oblong, entire, lightly 3-nerved, abruptly narrowed into a slender petiole; scales of the hemispherical involucre 10-14, oblong-lanceolate, acute, shorter than the disk; flowers yellow; rays 6-9, exserted, oblong, often 3-toothed; akenes linear-cuneate and 4-angled; paleæ of the pappus linear-lanceolate, hyaline, mucronate or short-awned by the excurrence of the stout midrib or else in the outermost flowers oblong and pointless. — Wind River valley, on high gypseous ridges.

A narrow-leaved form of this ambiguous composita (var. *oblongifolia*) was collected by Prof. Newberry in McComb's expedition several years ago, at "San Juan" (either in Utah or New Mexico); and Dr. Parry has now found it much farther north. The character here given is copied from a still unpublished revision which I have recently made of the genus, as now extended according to the views of Bentham in the Genera Plantarum, where it is made to include *Achyropappus* (of which section we have *S. Neo-Mexicana*, *S. Bigelowii*, *S. Woodhousei*, *S. pedata*, and *S. biternata*, all but the first published by me under *Bahia* or *Achyropappus*; and now the present species adds a peculiar section, *Platyschkuhria*, with perennial root, peculiar foliage and habit, but the head and flowers of *Achyropappus*. — A. GRAY.

153. ARNICA PARRYI. — About a foot high, hirsute and glandular; stem simple, naked above, bearing (excepting bracts) only one or two pairs of cauline leaves and 1-5 rather small heads; radical and lowest cauline leaves ovate or ovate-lanceolate with obtuse or acute base tapering into a short margined petiole, lightly 3-5-plivelned, acutely denticulate; the others small and sessile or bract-like; lateral peduncles short; involucre somewhat turbinate; rays none; akenes almost glabrous; pappus densely barbellate in the manner of *A. mollis*.—*A. angustifolia*, var. *discoidea latifolia* Gray in Sill. Jour. 33, p. 238. *A. angustifolia*, var. *eradiata* Gray in Proc. Acad. Philad., 1863, p. 68. Mountains of Colorado (Parry, Hall and Harbour, Greene), and now found by Dr. Parry in Wyoming. Rev. Mr. Nevius sends a specimen from the mountains in Oregon. Allied on one hand to *A. mollis*, on the other to broad leaved forms of *A. alpina*. Seemingly a well marked species in a genus the species of which are hard to limit.*—A. GRAY.

156. ARNICA FOLIOSA Nutt.—*A. Chamissonis* Torr. and Gray, in part. This is a dwarf and less downy form of a species which abounds from the Rocky Mountains to

---

* Our North American species throughout appear to have yellow anthers and more or less hairy corolla-tube,—except the two peculiar to Unalaska and the other Aleutian Islands, which have blackish anthers. Both were collected by Harrington and Dall in the exploration under the command of the latter; and they seem to be distinct, although Herder has lately combined them. *A. Unalaschkensis* has the tube of the corolla wholly glabrous. This is said to be the case in the original description of *A. obtusifolia* Less., but in our specimens the many jointed hairs common in the genus certainly occur. The *A. Chamissonis* of Schmidt's Flora Sachaliensis has the same dark anthers, and in foliage also differs considerably from the original *A. Chamissonis*.—A. GRAY.

the Sierra Nevada, in the latter region passing into var. *incana*, a densely white-tomentose variety. It is Nuttall's *A. foliosa*, which I had referred to *A. Chamissonis*, incorrectly, as I am now convinced, but all these species seem to run together inextricably. Nuttall's name is a good one, and so, on the whole, is the species which on a survey of the genus it seems necessary to revive.—A. GRAY.

202. PHELIPÆA (APHYLLON) LUTEA.—Resembles *P. fasciculata*: but the whole plant is of a light yellow color and more glandular-hairy; peduncles only about twice the length of the flower; corolla sulphur-yellow.—Dry and sandy hillsides, Owl Creek; parasitic on roots of grasses.—C. C. PARRY.

215. PEDICULARIS PARRYI Gray, *var.* PURPUREA.—Abundant in pine woods at the foot of Yellowstone Lake. I do not find any marked characters to distinguish this from *Pedicularis Parryi* of the Colorado Rocky Mountains, except the larger dull *purple* flowers, the lanulose-ciliate bracts, filaments slightly hairy, and leaves more sharply serrate, with the divisions *broader* and *less* divaricate.—C. C. PARRY.

218. ORTHOCARPUS PARRYI.—Differs from *O. pallescens* Gray in somewhat greater height (almost a foot high) and in the close and short cinereous pubescence; corolla broader and yellowish, its more decidedly trisaccate lower lip equalling in length the broad galea, its 3 lobes equal, oval, obtuse, about the length of the saccate portion.—Pacific Springs, etc. Flowers 7 lines long; the lower rather distant, in the axils of green and foliaceous laciniate-pinnatifid bracts; calyx 2-cleft to the middle, nearly equalling the yellowish corolla and apparently slightly yellowish.—A. GRAY.

CAREX TENUIROSTRIS Olney.—Spike ovate or nearly round (8-11 mm. long, 7-10 wide), composed of 5-10 or more spikelets in a dense head staminate at the base; bracts short, leafy, lower margins hyaline; stigmas 2; perigynium narrow, ovate, lanceolate (3·2 mm. long, ·8 mm. wide), tapering to a very slender beak with an obliquely cut membranous orifice fringed at top, faintly nerved, doubly serrate and winged on the margins from the base of the oblique cut to half way down, longer than the entire ovate acute hyaline green nerved scale (2-2·1 mm. long, 1-1·5 broad), never hispid; achenium straw colored, oblong, stiped (1·4 mm. long, ·6 mm. wide).—Stipe 4 mm. long; achenium 1·4 mm.; style 2·2 mm.; stigmas ·8-4·8 mm.; root fibrous, culm 6-8 cm. high, leaves flat; margin finely serrated, rough and pointed at top, narrow, and shorter than culm.

It resembles *Carex Haydeniana* in size, leaves and general aspect. It differs in the color of its spikes, its bracts, but principally in its perigynium which is narrower, and in its orifice fringed at top, and in this differing from its other close ally *C. leporina* and from *C. festiva* more remote. From *C. festiva* it differs as indicated, and in the wings and serratures of the perigynium not extending to the base.—S. T. OLNEY.

307. ISOETES BOLANDERI Engelm.—Trunk deeply 2-lobed; leaves (5-20, 2-4½ in. long) 4-angled, slender, tapering to a very fine point, bright green, soft; epidermis cells elongated; with stomata, but without peripherical bast bundles; sporocarp mostly oblong, covered about ¼ or ⅓ by the velum, unspotted; macrospores (0·30-0·45 mm. wide) beset with minute points and wrinkles; microspores (0·026–0·31 mm. long) more or less papillose or spinulose, deep brown.—In ponds and shallow lakes on the Sierra Nevada of California, at an altitude of 5,000–10,000 feet, "scattered or rarely in small patches" (Tuolumne, Mount Dana, Mono-trail, Cisco, Mary's Lake, *H. Bolander*, 1866 and 1870), and on the Rocky Mountains, "densely cæspitose (Yellowstone Lake 7,400 feet alt. *C. C. Parry*, No. 307, 1873).

This species represents in the western mountain regions our eastern wide-spread *Isoëtes echinospora* var. *Braunii*, and the very local *I. saccharata*. Both collectors found it growing in soft mud covering gravel, and always submerged, but the abundant stomata would seem to indicate that the plant, at times, vegetates out of water. Leaves very slender, ⅓-½ lines in diameter in the lower third, very broad winged below and towards the base. The minute, mostly pointed warts on the macrospores are often confluent, and then represent short wormlike wrinkles; in some specimens I find them almost obliterated. The specimens from Yellowstone Lake are characterized by rather smaller macrospores (0·28 - 0·38 mm. wide) and a little smaller (0·026 - 0·029 mm.) almost smooth microspores, and may be distinguished as var. *Parryi*.

The only other species of Isoëtes, thus far found in the western mountains and on the Pacific slope, are:

ISOETES PYGMÆA Engelm.—Very submerged, few (5-10), short (¼ to 1 inch), stout, rapidly tapering dark-green leaves, with very short, often even square epidermis cells, without stomata or bast-bundles; circular sporocarp with a very narrow velum; macrospores 0·36–0·50 mm. wide, marked with smaller and more regular, rarely confluent, rather sharp points; microspores (0·024–0·027 mm. long) brown, very minutely papillose or almost smooth.—In large patches in mud, covering gravel, deeply submerged in running water, on the Mono-trail, eastern declivity of the Sierra Nevada, 7000 feet alt., *H. Bolander*, 1866. Closely allied to the last species, distinguished by its stout, short leaves without stomata, and the markings of the larger macrospores, etc.; in many respects near *I. lacustris.*

ISOETES NUTTALLII A. Braun in litt.—Terrestrial, trunk scarcely lobed; leaves (20–60, 3–7 in. long) 3-angled, slender, firm, erect, light-green, with numerous stomata and 3 peripherical bast-bundles; sporocarp mostly oblong, entirely covered by the velum; macrospores (0·35–0·52 mm. wide) densely covered with minute but prominent, rounded warts; microspores (0·025–0·028 mm. long) papillose, deep brown.—On damp flats or springy declivities in Oregon; on the Columbia, *Th. Nuttall*, 1833; Camass Prairies of the Cœur d'Aleines, *Chs. Geyer*, 1843; Willamette valley, *E. Hall*, No. 693, 1871. Thin but firm leaves, as most land Isoëtes have, with three strong bast-bundles corresponding to the 3 angles. Trunk rhombic in transverse section, only superficially divided by a shallow groove into two lobes. Closely allied to *I. melanopoda* of the Mississippi Valley, which Mr. Hall lately discovered also in Texas, but resembling in the velum the two Florida species *I. flaccida* and *I. Chapmani.*

ISOETES ECHINOSPORA Dur., var. BRAUNII Engelm.—In the Uintah Mountains, at 9500 feet alt., *S. Watson.* The westernmost and the highest known locality of this species.—G. ENGELMANN.

ÆCIDIUM PSORALEÆ.—Spots none; peridia abundant, generally occupying all the lower surface of the leaf, rarely a few on the upper surface, short margin crenulate; spores sub-globose and sub-elliptical, brownish yellow when fresh, yellowish when dry, ·0007–·0008 inch long.—Parasitic on leaves of *Psoralea floribunda*, Colorado Territory.—C. H. PECK.

ÆCIDIUM PARRYI.—Spots none; peridia usually occupying all the lower surface of the leaf, prominent, bright-colored, margin subentire; spores subglobose, bright chrome yellow, ·0008–·0009 inch in diameter.—Parasitic on leaves of *Smelowskia calycina* Meyer. Wyoming Territory.—C. H. PECK.

REVIEWS AND BOOK NOTICES.

REVISION OF THE ECHINI.*—The third part of this elaborate work, the first and second parts of which we noticed in the preceding volume of this journal, has appeared printed in the same beautiful style as the preceding portion.

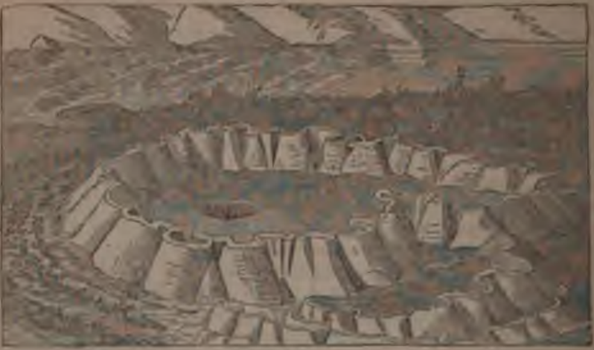
The present part contains the descriptions of the species of recent Echini (sea urchins), with a full discussion of the ordinal and subordinal characters. The plates are beautifully executed with many details both of the external parts and the internal anatomy.

---

* Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College. No. vii. Revision of the Echini. By Alexander Agassiz. Part iii with 45 plates and the plates illustrating Part iv. Cambridge, 1873. Royal 8vo, pp. 383-628.

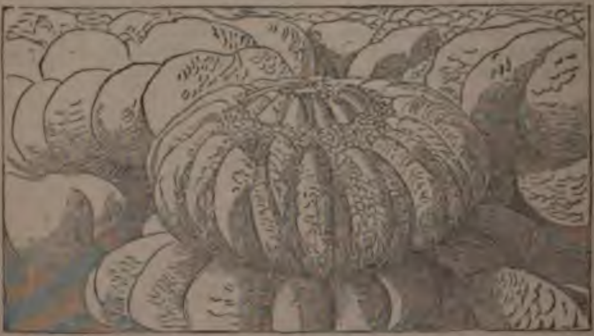
Hayden's Geology of the Territories.—The second part of our notice of this interesting volume (see p. 726, vol. vii) has been unavoidably crowded out of our pages. We have already referred to the wonderful geysers and hot springs of the Yellowstone region. In Dr. Peale's report occur the accompanying illustrations of these phenomena:—Fig. 58 illustrates a rim about a Geyser-tube, on the Upper Fire Hole Geyser Basin, due to the silex precipitated from the heated waters; Fig. 59, globular masses in the crater of the Turban Geyser; and Fig. 60 shows the ornamental character of the border of the springs, while Fig. 61 is a view of the singular basins of hot springs at Gardiner's River, in the Yellowstone National Park.

Fig. 58.



Rim about a Geyser-tube, Upper Fire Hole Basin.

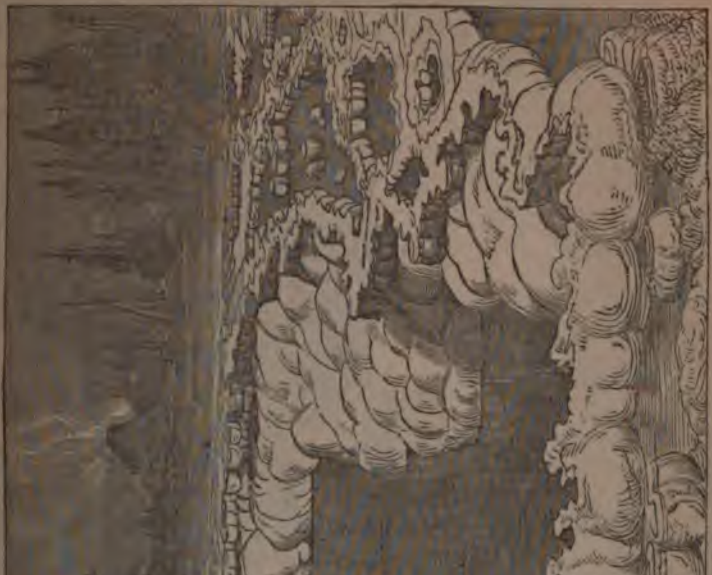
Fig. 59.



Globular Masses in the Crater of the Turban Geyser.

In his rather long and interesting report on the lignite coal and its flora, Prof. Lesquereux brings forward new facts in regard

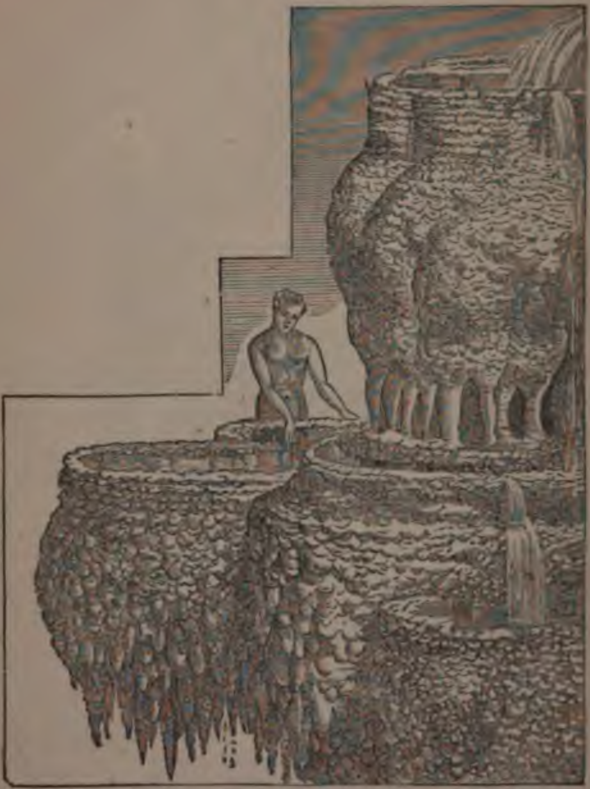
Fig. 60.



Oblong Geyser near the Giant, Upper Basin, showing the ornamental character of the borders of the springs.

to the analogy of some vegetable forms of our Cretaceous rocks with the plants of our time, and also of the Miocene flora of Europe; and he maintains that the whole lignitic coal formation of the Rocky Mountains is, "from the base of the fucoidal sandstone, a Tertiary-Eocene formation." Prof. Meek follows with a report on the invertebrates, and Prof. Cope reports on the Eocene vertebrate fossils of Wyoming, with several lithograph plates; concluding with some remarks of much interest on the character of the types of vertebrates, giving phylogenies of the mammalian orders and of the genera of the Testudinata. Other papers are contributed by Messrs. Leidy, Thomas, Merriam, Horn, Hagen,

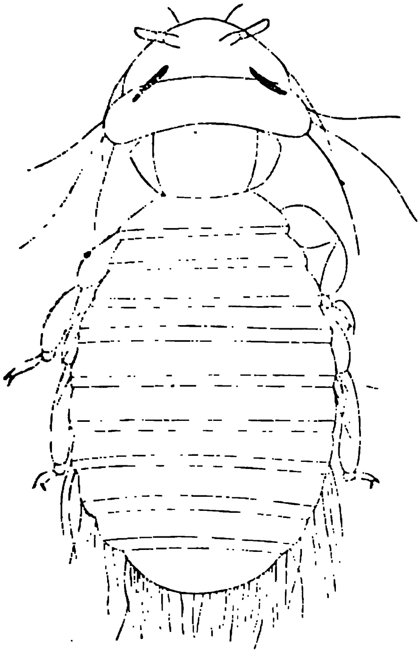
Fig. 61.



Basins of Hot Springs at Gardiner's River, Yellowstone National Park.

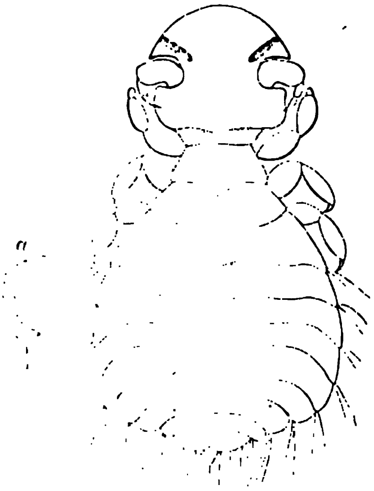
Packard, Coulter, Gannett and Stuart. Dr. Packard describes several new species of bird lice, i. e., *Menopon picicola* (Fig. 62), *Goniodes Merriamanus* (Fig. 63), *G. mephitidis* (Fig. 64) from the skunk, *Nirmus buteonivorus* (Fig. 65) and *Docophorus syrnii* (Fig. 66), the latter from New York, with some notes on the common

Fig. 62.



Parasite of Woodpecker.

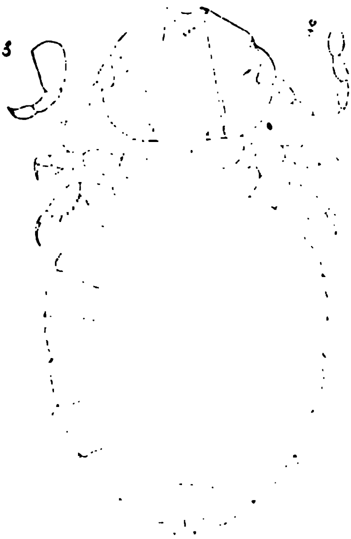
Fig. 63.



Parasite of Dusky Grouse.

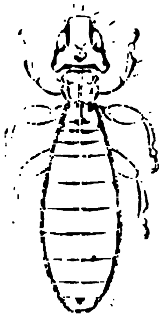
cattle tick of the west and Central America (Fig. 67), *Ixodes bovis*, upper figure, natural size, lateral view; lower, enlarged, with the mouth-parts (67 *a* much enlarged). A description is added of the Texan *Argas Americana* (Fig. 68, much enlarged), a near ally of the well known *Argas Persicus* which is so annoying to travellers in Persia.

Fig. 64.



Parasite of Skunk.

Fig. 65.

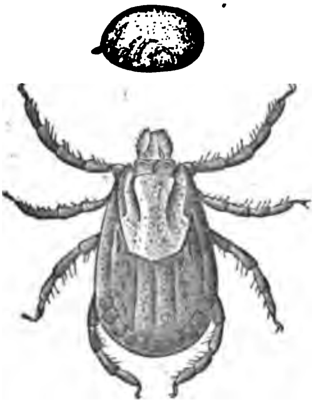


Parasite of Swainson's Buzzard.

Fig. 66.

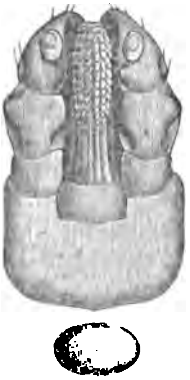
Parasite of Barred Owl.

Fig. 67.



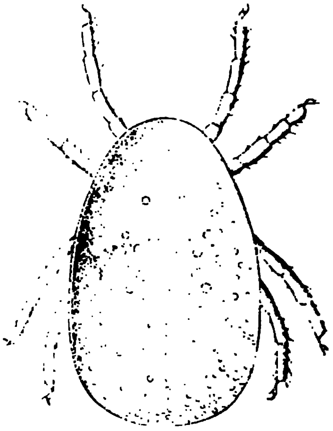
Cattle Tick.

Fig. 67 a.



Mouth parts of Tick.

Fig. 68.



American Argas.

GIRARD'S INSECTS.[*]—This is a French work modelled after a similar plan to Packard's Guide, but much more pretentious and less convenient for daily use; like the latter, it contains special reference to injurious insects and will prove of particular value to agriculturists.

The introductory portion covers two hundred and forty pages and is divided into eight sections: *i. e.*, on definitions, on the anatomical and physiological study of the functions; on the nervous system; on instinct and intelligence; the chase and preservation of insects; on paleontology; on geographical distribution; and on species and classification. Nearly half of the introduction is devoted to the second section (on the functions) which includes also much that is of great interest to the general student. We naturally look for twenty pages on animal heat, where the reader will find the result of Mr. Girard's researches in very convenient form. A long chapter is devoted to the mode of collecting and preserving insects and the introduction is terminated by a list of important entomological works.

In the special part of the work the author defines in general language the characteristic features of the larger groups, and under each gives brief descriptions of the principal genera; species are not treated at length unless they are injurious; thus fifteen pages are given to the cockchafer. The history and habits of the insects are briefly described, so that the work becomes a running commentary upon the principal forms of beetles; our own acquaintance with Coleoptera is insufficient to enable us to judge how carefully the later sources of information have been gleaned, but there is no reference whatever to LeConte's views of the position and value of the Rhynchophora.

The plates accompanying the volume, except the first six, which are anatomical, are confined to Coleoptera, and with a single exception are the same as those published years since in Guérin's "Iconographie du Règne animal," but a few figures have been replaced by new illustrations. References to the plates are made throughout the work, but we miss a connected reference to any but those which treat of anatomy. There is also no index. These defects will doubtless be remedied at the close of the whole work, which must continue through several volumes.—S. H. S.

---

[*] **Les Insectes.** Traite elémentaire d'entomologie comprenant l'histoire des espèces utiles et de leurs produits, des espèces nuisibles et les moyens de les detruire; l'étude des métamorphoses et des mœurs les procédés de chasse et de conservation; par Maurice Girard. Introduction, Coleoptères, avec atlas de 60 planches pp. viii, 840. 8vo. Paris, 1873.

SOLAR PHYSICS.*—Our geological readers will feel an interest in a work by one of the pioneers in the new series of researches on the nature of the sun, which have tended to take astronomy out of the exact sciences and place it on a rank with its sister science, biology. The work is largely an essay on cosmical geology. In many ways it commends itself to the geologist and biologist, and is a fresh illustration of the close connection existing between the various branches of physical science. It is divided into two parts: I. A popular account of inquiries into the physical constitution of the sun, with special reference to recent spectroscopic researches; and II. Communications to the Royal Society of London, and the French Academy of Sciences, with notes.

The first part is naturally of more general interest, embracing topics of which the following are some of the subjects:—What is a Sun; The telescopic Appearance of the Sun; The Sun as a Type of the material Universe; The Place of life in a Universe of Energy; The Atmosphere of the Sun, and several chapters on the Eclipse. The style is clear and interesting, while the spirit of the writer is sanguine and bold, such as has marked the editorial conduct of "Nature," in which journal some of these essays have appeared.

Certainly the author has reason to thank his publishers for the sumptuous appearance of the volume, taking rank as it does with the most beautiful works of a similar nature that have appeared recently in England and France. All devout astronomers should, as becoming their profession, thank heaven for the appearance of so fair and enticing a work, which will win its way to the warm appreciation of many a non-astronomical reader.

THE BIRTH OF CHEMISTRY.†—This little book is a reprint of an interesting series of papers which have appeared in "Nature." It is a résumé of the earlier history of chemistry, before it became a science, from the times of the early Greek philosophy down to that of the fathers of modern chemistry, Lavoisier, Priestley and others, but not including their works. Those who know nothing of chemistry will find this account entertaining. The illustrations will add to its interest.

---

*Contributions to Solar Physics. By J. Norman Lockyer. London, Macmillan and Co. 1874. 8vo. pp. 676. With colored plates and numerous woodcuts. $10.00.

†The Birth of Chemistry. By G. F. Rodwell. With numerous illustrations. Nature Series. London, Macmillan and Co., 1874. 12mo. pp. 135. $1.25.

NORTH AMERICAN MOTHS.*—The 8th and 9th parts of Mr. Stretch's interesting illustrations, completing vol. i, have appeared with three plates, the last of larvæ, some of them only tolerably well drawn, but of great interest. Though the work is partly a compilation, yet much original matter is incorporated, and it is the only manual we have of the most interesting portion of our moth-fauna. Several new species, western and Pacific, are described and figured.

BOTANY.

INVESTIGATIONS RESPECTING THE FERTILIZATION OF ABUTILON.—The complete sterility of certain plants with pollen from the same flower (*Corydalis cava*), or even from all flowers from the same stock (species of Abutilon, Bignonia, Oncidium, etc.), is only a remarkable case under the law that self-fertilization gives rise to weaker descendants than crossing. And, further, this law, of which a proof is afforded by every flower which, through the attraction of odor or color, invites bees or butterflies to the enjoyment of honey, and thereby to the accomplishment of crossing, is only a particular case under the more general law, viz ;—that close breeding in-and-in between near relations is productive of mischief; for speaking of individual cases, anthers and pistil of the same individual plant, or the same flower, are the closest conceivable relatives.

A still more general scope can be given to the last law if we comprise in it, also, the diminution of fertility, which, in all degrees even to complete sterility, occurs as a consequence of close relationship of the plants crossed, and in the union of hybrids. Every plant, so to speak, requires for the production of the strongest possible and most prolific progeny, a certain amount of difference between male and female procreative elements which unite. Fertility is diminished as well when this degree is too low (in relatives too closely allied), as when it is too high (in those too little related). The complete accord between "illegitimate" descendants of dimorphous and trimorphous plants on the one side, and hybrids of different species on the other side, authorizes in fact such a grouping together under a common point of view of kinds of infertility occasioned by opposite causes. It is self-evident that the fact can be merely expressed, but not explained. Likewise, naturally, only one of the many relations conditioning the greater or less fertility of a union can be expressed.

---

* Illustrations of the Zygænidæ and Bombycidæ of North America. By R. D. Stretch. Vol. i, parts 8 and 9 (and last). San Francisco, Cal., 1874. 8vo., pp. 185-242.

In a species the greater the difference of sexual elements, requisite to the attainment of the highest degree of fertility, the greater will be, in general (*cæteris paribus*), the difference between the plants which can produce offspring with each other. In other words, species which, with pollen of the same stock, are wholly sterile, and even with pollen of nearly allied stocks are more or less infertile, will generally be fertilized very readily by the pollen of another species. The self-sterile species of the genus Abutilon, which are, on the other hand, so much inclined to hybridization, afford a good example of this theory, which appears to be confirmed, also by Lobelia, Passiflora and Oncidium.

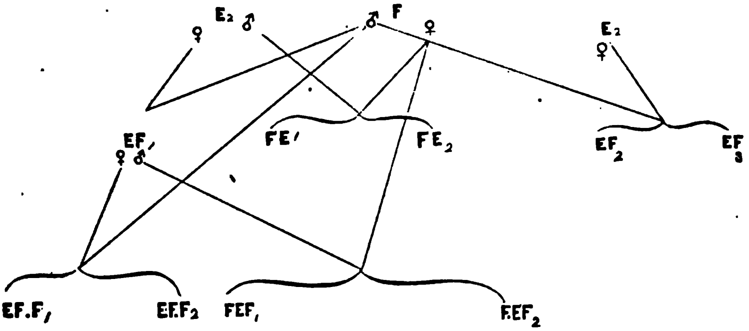
I will not further present these general observations. They merely indicate in what sense, and in what connection I have wished to look upon the following example of infertility between near relations.

In the following *A. C. E. F. M. P.* denote six indigenous species of Abutilon. . . . . . For indicating the simple hybrids the letters of the united species are placed in juxtapositon without other signs, and the *maternal* species *first*. Thus *EF* stands for a hybrid whose mother is *E* and whose father is *F*. In the case of union of these simple hybrids among themselves or with simple species, a point is placed between the symbol of the mother, and that of the father following; *F. CF* had, consequently, *F* for the mother, *CF* for the father; *CE. S* had *CE* for the mother and *S* for the father. Numbers placed under and at the right of the letters denote the individual stocks of a species or a hybrid; FS_1 FS_2 FS_3 are, for example, three different stocks of the hybrid *FS*.

The four plants $EF.\ F_1$, $EF.\ F_2$, $F.\ EF_1$, $F.\ EF_2$ are brothers and sisters, having had the same parents *F*, and EF_1.

Nine flowers of $F.\ EF_1$ dusted with pollen of other flowers of the same stock produced not a single fruit.

Twenty flowers of $F.\ EF_1$ dusted with pollen of $F.\ EF_2$, $EF.\ F_1$, and $EF.\ F_2$, produced three fruits with an average of 1·3 seeds.



On the other hand there were the following results with

							Seeds.
10	Flowers	*F. EF*	impregnated	by *FE*, and FE_2	10	fruits	4·5
11	"	"	"	" EF_2 " EF_3	10	"	4·6
10	"	"	"	" *F*	9	"	4.6
6	"	"	"	$F.\ CF_1$ and $F.\ CF_2$	6	"	4·5
1	"	"	"	" FS_1	1	"	4.7

The results following the dusting of the brothers and sisters were not owing to the bad behavior of the pollen since on other plants it was completely potent; the pollen or $F.\ EF_2$ produced fruit rich in seeds in the plants FS_1, that of *EF. F*, on FE_2, that of $EF.\ F_2$ on *F*. Also the pollen of $F.\ EF_1$, produced numerous seeds which so far as sown appear capable of germinating, from the plants *F. F.* CF_2, FS_1, and FS_2.

The seeds produced by $F.\ EF_2$ and *F. EF* have, moreover, germinated and given strong plants which, up to this time, have kept pace in growth with those from EF_2, F, $F.\ CF_2$, and FS_1.

The foregoing examples show that in hybrids of Abutilon, and probably so in pure species of the genus, there are many cases of more or less complete infertility between nearly related plant-stocks, between parents and children, between brothers and sisters and even half brothers and sisters. If the foregoing exposition of the connection between relationship and fertility is correct, we may hope to indicate in other plants similar instances of diminished fertility through too near relationship, but we may expect to find complete sterility between relations in those species only which like Abutilon are infertile with pollen of the same stock. . . . . .

Darwin, with his accustomed keenness of vision, has expressed* the conjecture that this diminution of fertility, observed so many times, is not a consequence of their hybrid nature, but of too close breeding in-and-in, and I am glad to be able to offer, in the examples of diminished fertility and complete sterility as a consequence of too close breeding in-and-in, in Abutilon-hybrids, herewith communicated, a new proof of the accuracy of Darwin's hypothesis. —*From the German of Fitz Müller, Itajhy, Oct.*, 1872. G. L. G.

THE FERTILIZATION OF GENTIANS BY HUMBLE BEES.†—The fringed gentian (*Gentiana crinita*) resembles the above in having erect flowers and the stamens below the stigmas. The fringed lobes of the corolla spread at right angles. Humble bees work upon this very much as they do upon Andrews' gentian.

There seems to be almost no end to the various contrivances by which flowers are fertilized by insects. Flowers closely allied, of the same genus, are fertilized in different ways, so it is not safe to make general rules. We may think that insects will act in a certain way, according to our notion, but after carefully watching them, we shall often see that they are not doing as we supposed they would. We need many patient observers for many years yet, to repeat observations made on this subject and to make new ones; we want to know how our insects behave upon every species of flower from the time they first visit it, to the time it affords no nectar to attract them.—W. G. BEAL, *State Agricultural College, Lansing, Michigan, Nov.* 8, 1873.

ZOOLOGY.

GIGANTIC CUTTLE-FISHES OF NEWFOUNDLAND.—It seems, as will be seen by the following correspondence, that we were incorrect in saying that the first letter of Mr. Murray on this subject was addressed to the late Prof. Agassiz (p. 120). It was in fact written to Prof. Marcou. We make reparation for the inadvertency by publishing the following letters from Prof. Agassiz, of which copies have been furnished us by Prof. Marcou. They are interesting as being the last scientific letters written by their lamented author: —

---

* Orig. Sp., 4th ed., 295.

† By an oversight omitted from the note on p. 180.

MUSEUM OF COMPARATIVE ZOOLOGY,
Cambridge, Mass., Nov. 25, 1873.

My Dear Sir:—My friend Marcou has communicated to me your most interesting letter; and I am delighted at last to have so direct information concerning the gigantic cephalopods of the Atlantic, of which so much has been said since the days of Pontoppidan. I will now hunt up everything that is worth noticing upon the subject, and if you will allow me an examination of your specimen, the zoological characters of the creature might be made out from the parts preserved, as we do of imperfect fossil remains. I would also ask leave to publish the substance of your letter to Mr. Marcou, in connection with this. With great regard, yours very truly, (Signed) L. AGASSIZ.

ALEX. MURRAY, Esq., St. John, Newfoundland.

MUSEUM OF COMPARATIVE ZOOLOGY,
Cambridge, Mass., Nov. 26, 1873.

My Dear Marcou:—Thanks for the letter and the photograph that Mr. Murray has sent you. It is very curious, and with your permission, I shall publish the contents accompanied with remarks if Mr. Murray should send me one of the large suckers in order to compare it with those of the species of cephalopods known on our coast. I have written him to this end. I have made a copy of Mr. Murray's letter, and return you the original. The more I consider this discovery, the more does it interest me. It is truly important for the history of cephalopods. Ever yours,

(Signed) L. AGASSIZ.

Prof. JULES MARCOU.

LAWS OF GEOGRAPHICAL VARIATION IN NORTH AMERICAN MAMMALS AND BIRDS.—My attention of late having been again especially directed to this subject, I wish to say a word respecting a discussion that occurred concerning it in the NATURALIST some months since, during my somewhat protracted absence in the west; particularly in respect to Mr. Ridgway's article in the September number (vol. vii, pp. 548–555). With all due deference to the important contributions Professor Baird has made towards our present knowledge of this subject, I think Mr. Ridgway has hardly fairly represented the case. After stating what he claims as Professor Baird's generalizations, four in number (see Mr. Ridgway's article), he says: "Here then are three laws of climatic or regional variation in size and proportions, and two of color, in which Mr. Allen is anticipated by Professor Baird."

Generalization "1" of Mr. Ridgway's enumeration refers to variation in size with locality, and is a law which was most unequivocably established by Professor Baird. Generalization "2" refers to the enlargement of the bill in Florida and cape St. Lucas birds, while generalization "3" refers to the "longer tails of western birds than of eastern examples of the same species." Generalization "4" refers to color, and will be presently noticed more in detail. In respect to generalizations "2" and "3," Professor Baird only refers to the disproportionate enlargement of the bill and tail at certain localities, as noteworthy facts, and, so far from explicitly stating them as general laws, he says in a foot-note, referring to the increased size of the bill, "This disproportionate difference of size at cape St. Lucas and south Florida is probably connected with the limited range of the species in those regions, which have thus an insular rather than continental relationship;"* thus apparently looking upon these variations as local phenomena. Neither in the case of the enlarged bills, nor the lengthened tail, does he hint at any general geographical law of variation of which these are simply the expressions, whereas my announcement of the *law of the enlargement of peripheral parts to the southward* included not only those instances noticed by Professor Baird, but a multitude of others I had myself observed, both among mammals and birds, and at numerous localities in addition to Florida and lower California. In respect to the tail it was increased in length at the *southward*—not at the *westward*—in accordance with the above law to which I called attention.

As regards laws of color variation, Professor Baird merely makes the general statement that "specimens from the Pacific coast are apt to be darker in color than those from the interior, the latter frequently exhibiting a bleached or weatherbeaten appearance, possibly the result of greater exposure to the elements and less protection by dense forests,"† whilst I announced a region of more rufous tints in the middle portions of the continent, darker tints on the Pacific coast north of latitude 40°, and light colors from the arid plains and deserts, as well as the law of increased intensity of color to the southward; at the same time correlating these general facts with the relative amount of aqueous precipitation and the hygrometric conditions of the atmosphere over these different areas of the continent.

---

* Amer. Jour. Sci. and Arts, 2d series, vol. xli, p. 191.

† Amer. Jour. Sci. and Arts, 2d series, Vol. xli, p. 192.

The statement Mr. Ridgway makes, notwithstanding the generally complimentary tone of the article as regards the present writer, that all the laws I announced (with one exception) "are substantially the same as the generalizations made by Professor Baird in 1866," seems to me to be by no means wholly warranted. Being forced to refer to the matter, I may as well state here that I claim the three following general laws as original: viz: 1, increase of intensity of color southward; 2, greater depth of color with increased atmospheric humidity; 3, enlargement of peripheral parts to the southward. These, with the fourth law relating to size, cover, in a general way, geographical variation in proportion, size and color. Baird's law of size and his facts of variation in respect to the proportional development of parts, taken with similar ones I had myself observed, were of course incentives to further research, and suggestive of the probable existence of some general laws of geographical variation of which these facts were the expressions.—J. A. ALLEN.

THE HABITS OF POLISTES AND PELOPÆUS.—My friend, Mr. Uhler, will pardon my incredulity; but the conviction forced itself on my mind, in reading the interesting paper on pp. 678–9, vol. vii, that some one had sadly confounded the two genera above mentioned.

First, the description of the mud cells exactly applies to those of our common *Pelopœus lunatus* Fabr., as do, also, the descriptions of the method of building, and of storing them with young spiders. The actual cells, which I saw at Portland, would be at once recognized as belonging to this species by those familiar with its habits—the unusual length of some of them resulting from the nature of the beetle burrow or cavity in which they were built. *Secondly*, the habit which Mr. Uhler deems exceptional, or not belonging to Pelopæus, viz., that of not nursing its young and of sealing up the cell when once stored is precisely the habit which *does* belong to Pelopæus and which *does not* belong to Polistes. Mr. F. Smith has recorded facts which would indicate that some of the digger wasps, such as Mellinus, may open their burrows from time to time to supply fresh food to their young;* but we have yet no positive proof of the fact, and I know of nothing on record to indicate that any other digger wasp does so. The fact that old mud daþs are often found, in which the wasp egg had failed to hatch, and in which the spider food, in consequence, had not been appropriated, is sufficient proof, if proof were wanting, that Pelopæus never does so.

---

* Ann. and Mag. Nat. Hist., May, 1869.

The habits of Polistes, as I think every one who has observed them must admit, are absolutely incompatible with Mr. Uhler's conclusions. They have recently been most admirably set forth by Siebold in his last work on Parthenogenesis.*

A large weather-worn impregnated female or queen founds the colony in spring, by the construction of a peduncled, gray, paper-like cell, at the bottom of which an egg is deposited. The cell is enlarged as fast as the larva increases in size, and other cells are, meanwhile, built adjoining the central one. The young are always fed with the masticated flesh of other insects, such as small caterpillars, small moths, etc., and the mother always rejects the food found in the stomachs of these herbivorous species. The cells are never closed until the full grown larva closes them. The first generation consists of females only; or, more properly, female workers differing from the workers of Apis in being always fertile, but, from necessity, parthenogetically so. They have precisely the same structure as the queen, but are distinguished by their smaller size and brighter color, especially of the wings. By their aid the nests increase in size, or new nests are built, and in the fall of the year the larger females and the males appear. Occasionally honey is found in the cells, but its use is not fully understood.

Now have we a species so divergent from this habit as to borrow the very different habit of Pelopæus? For my own part I have too much faith in the unity of habit in the same genus to believe it without better evidence. Larrada and Sphex, which generally burrow in the ground, present exceptional species which build nests above ground in the curl of a leaf,† but the species which thus diverge in habit also diverge in structure from the typical genus. Again in Agenia which generally builds mud cells above ground, Mr. Smith has shown that one species (*A. variegata*) burrows in the ground, Yet these exceptional differences in the habit of the same genus do not begin to compare with those between the habit of Pelopæus and Polistes; and if Mr. Uhler's observation is a correct one, it is a most remarkable entomological discovery.

---

* Beiträge zur Parthenogenesis der Arthropoden, 1871.

† Packard's "Guide," pp. 165 and 169.

The Polistes which Mr. Uhler exhibited at Portland is a quite common species (or perhaps, more correctly speaking, variety), marked in my cabinet *P. fuscatus* Fabr., and which *I know to build paper-like nests*, according to the habit of the genus. In winter collecting I constantly meet with it and other species hibernating in old hollow logs and stumps, and I cannot help thinking that Mr. Bryan, finding it in the same log with his mud cells, jumped to the conclusion that it was the architect of those cells; and that its yellow marked body and legs prevented his distinguishing it from *Pelopæus lunatus* which he afterwards observed building mud cells. At all events, I hope Mr. Uhler will tell us whether or not he himself observed any of the habits described, and will give us that confirmation, of so anomalous a fact, which will prevent all incredulity about it in the future, and which the article in question fails to give.—C. V. Riley, *Dec.* 3, 1873.

Notes on the Plant Lice.—That aphides, in the spring of the year, are developed into wingless forms from ova which were deposited at the close of the preceding autumn, and which have remained dormant during the famine winter months, I believe was the theory of naturalists till the year 1852. At this time Prof. Owen, in his famous Hunterian lecture on the generation of insects, claimed the reproduction of winged individuals to be an occasional occurrence, and also the exceptional mode.

My observations during the past season have been of such a character as to indicate that the professor is not wholly correct. From the first appearance of plant lice down to within a comparatively recent date, numberless winged individuals of *Aphis rosæ*, *mali*, etc., have been noticed, associated with clusters of the apterous form, but more usually single or in pairs, upon their favorite plants, at such distances from well-established colonies as to give warrant to the belief that wings were solely acquired for the purpose of diffusing the species.

In some carefully conducted experiments which I have made, some of these winged forms proved quite as prolific as the wingless; while others, apparently of the same age, manifested indications of sterility, from which latter fact it seems just to conclude that these were sterile females.

Further, it has been strongly affirmed by those who have made this peculiar group their study down to the aforementioned date, that procreation from a virgin mother continues until the eleventh generation is exhausted; and that when this period has been reached, winged individuals of both species make their appearance, which, after having celebrated their nuptials in mid-air, repair to some suitable plant where the females deposit their ova for the continuation of the species, after which they both die. Prof. Owen, in his writings, says "When this exhaustion occurs, some members of the last larval brood are metamorphosed into winged males, others into oviparous females," the latter being apterous. That such is only partially true I am satisfied from observations made during the latter part of October upon the *A. mali* of Harris.

This species, from its convenience, has received very careful attention. On the 26th of October last, while engaged in an examination of some of the principal shoots of a *Spiræa corymbosa*, which seem to be particularly adapted to the growth and well being of the above species, I observed hundreds of wingless females engaged in oviposition. Directing my glass to the leaves, where scores were still deriving a scanty and precarious subsistence, I noticed many smaller specimens which presented quite a contrast as regards size when placed by the side of their plump associates. The former, from the endearment which they lavished upon the latter, I soon satisfied myself were males. Upon other portions of the same field of view were many in the act of copulating. One particular phase of animal life very forcibly impressed my mind on this occasion; to wit, the ardent temperament of the males, and the comparative unconcern of the females previous to coition.

Long and anxious watching has convinced me that in the fall of the year not a single winged individual of either sex is to be found in this species, and further that the essential duties of reproduction and of oviposition are performed without the necessity of wings, and generally upon the very stalks where the insects were born and lived.

In size, the males of *A. mali* are vastly inferior to the females, being less than one-half the latter. Externally they appear like undeveloped females. Upon any other occasion than the present, I should assuredly have characterized them as females which a healthy, vigorous nutrition would have pushed unto perfection.

That they are males has been conclusively shown. But what has wrought the change? I think it can be shown that lack of nutrition, in consequence of a diminished supply of sap to the leaves, has been the instrument at work. If continuance of warmth and consequent plant-vitality are conditions favorable to an almost endless succession of the female type, a reverse order of things, by acting in a sudden manner, and at a certain stage of female life, producing a check to further development, must assuredly generate the opposite sex.—T. G. Gentry.

A Straggler in the Ohio.—On a recent visit to the Museum of Comparative Zoology my attention was called by Mr Bliss to a small fish labelled in my own handwriting several years since as follows: *A singular fish of a rare genus, Louisville, Ky.*, 1837. Nothing further is known as to the history of the specimen, but as 1837 was some ten years before Professor Agassiz began to form the unrivalled collection of fishes to which this specimen belongs, it is very probable that the label was a copy of some older one on the bottle in which the fish was received at the Museum, simply rewritten by myself sometime between 1856 and 1864. On making a careful examination of the fish it proved to be the *Gobiosoma molestum* of Girard, who described the species from a specimen obtained by Mr. J. H. Clark at Indianola, on the coast of Texas. Girard's description, with a figure, is in the Mexican Boundary Survey (Ichthyology, p. 27, pl. 12, fig. 14), 1859. Girard also describes the genus and species in the "Proceedings of the Philadelphia Academy," 1858, p. 169. The description by Girard applies perfectly to the Louisville fish and his figure is nearly correct. I note the following slight differences. Girard's specimen was two inches in total length, the Louisville specimen is two and one-half inches; Girard gives the fin rays as follows; dorsal VII + 12, anal 11, ventral 5, pectoral 16, caudal 20. My count of the Louisville specimen is, dorsal VII + 12, anal 12, ventral I + 5, pectoral 18 or 20, caudal 20; so that there is no important variation. Ventral 5, as given by Girard is probably a mistake due to his overlooking the small ventral spine which is common to nearly all members of the family. The proportions of the two fishes are the same. Girard's figure represents the rays of the first dorsal a little too far apart and the last rays are too short, as there is but little difference in the length of the rays of this fin. The rays of the dorsal are also slightly too long in proportion to the size of the fish figured, and the pectoral fin is also a little too long. The anal fin should be about one ray nearer the caudal. In the Louisville specimen the two dorsals are slightly connected at the base by a low membrane. This specimen has been so long in spirits that no markings of color can be traced, but the membrane of the fins shows dark shadings made up of small dark points.

Taking it for granted that the label is correct, this little fish must have made the perilous passage up the Mississippi river into the Ohio river, a journey north of about eight degrees of latitude and of many hundred miles distance. That it is not impossible for the fish to have made such a journey from salt to fresh water, we have the knowledge expressed by Dr. Günther as follows:—"This family [Gobiidæ] offers numerous instances of the fact, that a part of the individuals of one and the same species are entirely confined to fresh waters, whilst others live in the sea."

Independently of the interest given by the very probably correct label locating the place of capture as the Ohio river, the examination of the fish has proved that Girard's species is a valid one and distinct from the *Gobiosoma alepidotum* of our eastern Atlantic coast. This last is a more slender fish and differs in several other particulars. Should any of our readers have the opportunity of collecting the small fishes of the rivers flowing into the gulf of Mexico it would be well to be on the lookout for other specimens of the *Gobiosoma molestum*, which can be easily distinguished from other small fishes of our rivers by the following characters: head and body *without scales;* head about one-fourth the total length of the fish; eyes prominent and situated *very near together* on the anterior part of the head; two fins on the back, the anal fin under the second dorsal fin, pectoral fin rounded and well developed, tail fin rounded, ventral fins situated between the pectorals *and united together, forming a single pointed fin* lying close to the abdomen. —F. W. PUTNAM.

"ASSEMBLING" AMONG MOTHS.—I send you the following account of some of my observations, which you are at liberty to publish if you think it of any interest to your readers. Something like seven or eight years ago I was engaged in making a collection of insects and during the winter had collected quite a number of cocoons of the *Attacus Promethea* moth (Harris) which were placed for safe keeping in the furnace room of a small greenhouse, the doors and windows of which were kept closed to prevent the escape of the insects. One afternoon in the month of June, I observed a strange insect fluttering about the greenhouse, which it soon entered through a ventilator, where I captured it, and found it to be a male of the above mentioned species, an insect which, until then, I had never seen. During the afternoon, when upon another part of the farm, I saw another specimen, also a male, flying high and directing his course straight for the greenhouse. I was struck with the coincidence of seeing two of these insects in the same afternoon, but was fairly astonished upon entering the greenhouse in the evening to find some half a dozen of them, *all males*, sitting about upon various parts of the building, and apparently patiently waiting. They were all immediately killed and pinned. The next morning, when I entered the furnace room, I found that during the night one of my cocoons had produced a splendid *female* moth. Did those males come upon an errand of love? If so, by what sense were they guided to the right spot, a place entirely unlike the natural haunts of the insect?

During the past winter in riding about the country I collected several cocoons of this moth for the benefit of a young naturalist friend of mine, but retained one, which I hung upon the wall of my office.

On the morning of June 21st, a fine female moth came out and was the object of considerable interest to the occupants of the room. During the day I related the above incident to a gentleman and at the same time described the appearance of the male insect. I had occasion to be absent from the room a short time during the afternoon, and upon my return was told that a male moth had been there and fluttered in and out at the open window several times, but had finally disappeared. The next day was Sunday and the office was closed, but on Monday afternoon a male again made his appearance at the office window, came in, and after fluttering about the room for a space of ten or fifteen minutes, found the object of his search, and the connection was consummated before our very eyes. Let it be remembered that the office is situated upon the principal business street, in the centre of the city, and from half a mile to a mile from any place where such an insect would naturally be found. A friend who has a store some half a mile from my office upon the same street, has had an experience of the same kind. A cocoon which hung in her store produced a female moth, and within the next two days her store was visited by half a dozen of the male insects. Can any one tell me what fine sense this may be which guides this insect so far, and into such strange places in search of his waiting mate?—F. E. L. **Beal**, *Fitchburg, Mass., July* 7, 1873.

[We print the above as fair examples of "assembling" among moths. Nearly every entomologist has had similar experiences. It is a common occurrence. We are disposed to think that the male is guided by the sense of smell, as the antennæ of the silk moths probably possess this as well as the sense of hearing.—**Editors.**]

Organs of Hearing in Insects.—At the last meeting of the National Academy of Sciences, Professor A. M. Mayer exhibited experimental confirmation of the theorem of Fourier as applied by him in his propositions relating to the nature of a simple sound, and to the analysis by the ear of a composite sound into its elementary pendulum-vibrations; and to show experiments elucidating the hypothesis of audition of Helmholtz. Placing a male mosquito under the microscope, and sounding various notes of tuning-forks in the range of a sound given by the female mosquito, the various fibres of the antennæ of the male mosquito, vibrated sympathetically to these sounds. The longest fibres vibrated sympathetically to the grave notes, and the short fibres vibrated sympathetically to the higher notes. The fact that the nocturnal insects have highly organized antennæ, while the diurnal ones have not; and also the fact that the anatomy of these parts of insects shows a highly developed nervous organization, lead to the highly probable inference that Prof. Mayer has here given facts which form the first sure basis of reasoning in reference to the nature of the auditory apparatus of insects.

These experiments were also extended in a direction which added new facts to the physiology of the senses. If a sonorous impulse strike a fibre so that the direction of the impulse is in the direction of the fibre, then the fibre remains stationary. But if the direction of the sound is at right angles to the fibre, the fibre vibrates with its maximum intensity. Thus, when a sound strikes the fibrils of an insect, those on one antenna are vibrated more powerfully than the fibrils on the other, and the insect naturally turns in the direction of that antenna which is most strongly shaken. The fibrils on the other antenna are now shaken with more and more intensity, until, having turned his body so that both antennæ vibrate with equal intensity, he has placed the axis of his body in the direction of the sound. Experiments under the microscope show that the mosquito can thus detect to within five degrees the position of the sonorous centre. To render assurance doubly sure, Prof. Mayer, having found two fibrils of the antennæ of a mosquito which vibrated powerfully to two different notes, measured these fibrils very accurately under the microscope. He then constructed some fibrils out of pine wood, which, though two or three feet long and of the thickness of small picture-cord, had exactly the same proportion of length to thickness as the fibrils of the antennæ of the mosquito. He found that these slender pine rods or fibrils had to each other the same ratio of vibration as the fibrils of the mosquito.

CHANGE OF HABIT.—All who have travelled of late years on the St. John's River, in East Florida, must have noticed the cows standing for hours at considerable distances from the shore, thrusting their heads from time to time into the water. This is explained by a change of habit to which they have been driven, during the winter months, by a scarcity of suitable grazing on land. Grazing is never very good there at any time and compels them to feed on moss, young palmetto leaves, shoots of shrubs, etc., which under ordinary circumstances they would reject. The "river grass," which appears to be a species of Valisneria, has become a new and very considerable resource for food. It is said that this plant has established itself, within a few years, in the shoal waters of the lower part of the St. John's where it now covers large submerged tracts, and it is to obtain this that the cows have taken to their semi-aquatic habits. We have frequently watched them and have found that while gathering food, the head was kept beneath the surface for a period varying from fifteen to thirty-five seconds, during which time respiration was of course averted. We have recently seen a colt feeding in a similar manner. The hogs have also taken up this habit, but hold their heads under the water for a shorter time than the cows. The young calves, though they do not eat the "grass," follow the cows and may sometimes be seen with their heads only out of water.—I. J. WYMAN.

Spontaneous Generation.—Mr. E. Ray Lankester, after reviewing in "Nature" the results of recent work done in developing Bacteria, etc. in infusions, concludes that "archebiosis" of "abiogenesis" is "not in any way rendered more probable than it was before by Dr. Bastian's experiments with organic infusions. Prof. Smith and Mr. Archer, of Dublin, eminent authorities in the study of the lower algæ, have criticised in detail and suggested explanations of some of the statements in the third part of 'The Beginnings of Life,' viz., statements relating to the transformation of various species of organisms into each other. They show (the reader may consult Prof. Smith's paper in the October number of the 'Quarterly Journal of Microscopical Science,' 1873), that the asserted 'facts' of transmutation are not facts. It is abundantly demonstrated that the fundamental observations recorded by Dr. Bastian are erroneous, and that he has been mistaken."

Discovery of the Water Thrush's Nest in New England.—Among the trophies taken during a late collecting excursion in the western part of the state of Connecticut are the nest and four eggs of the long-billed water thrush (*Seiurus Ludovicianus*), discovered in June, 1873, at Franklin Station, New London county.

The nest was sunk behind a cushion of moss, and into the rotten wood among the roots of a great tree growing out of the bank (of the Yantic river) in such a manner that it was completely covered over, except just in front, by the roots of the tree. The nest itself was two and one-half inches in internal diameter, and rather shallow. It was rather loosely and carelessly constructed of fine grass and some little dead, fibrous moss: but beneath, a few, and about the outside, particularly in front, many dead leaves were put, as a sort of breastwork to decrease the size of the entrance and more thoroughly conceal the sitting bird. It was underneath the edge of a perpendicular bank eight or ten feet from the water.

The eggs were four in number, and fresh, though the bird was sitting upon them at 2 P. M. Before being blown they were of a beautiful rosy tint: but the ground color is lustrous white, giving the egg a polished look. They are more or less profusely spotted all over with dots and specks, and some obscure zigzagings, of two tints of reddish brown, with numerous faint points and touches of lilac and very pale underlying red. These marks are much more thickly disposed at the greater end where they form quite large blotches, but there is little indication of a ring. The eggs differ from those of *S. aurocapillus* in being more round and polished, and the spots generally larger and more distinct. One, however, is much paler than the other three. They measure ·80×·60; ·80×·60; ·79×·61, and ·75×·62 of an inch.

The female was shot after giving me a good opportunity to observe her behavior, when she thought herself entirely alone. She kept close to the water, but occasionally flew upon low twigs, alighting in a careful balancing attitude as though it were a great effort to hold on, and keeping up a coquettish flirting of her tail and queer, comical movements of her head. When frightened from the nest she uttered a few distinct chirrups but afterwards kept silent.—ERNEST INGERSOLL, *Cambridge, Mass.*

TWO RARE OWLS FROM ARIZONA.—Charles Bendire, U. S. A., well known as an enthusiastic and energetic ornithologist through his various communications to the NATURALIST, has lately sent me a specimen each of two rare species of owls, from the vicinity of Tucson, Arizona. Of *Syrnium occidentale*, Captain Bendire's specimen is the second ever obtained, the first having been procured by Mr. Xantus at Ft. Tejon, southern California, in 1859. The specimen collected by Captain Bendire is an adult female, collected Nov. 7, 1872. The manuscript notes on the label are as follows:—"Length, 17·25; extent, 42·25; bill, pale yellow; eyes, blue-black."

The specimen of *Micrathene Whitneyi* is the fourth ever obtained, the type being from Ft. Mojave, California, and the other two from Socorro Island, off the western coast of Mexico, in latitude 18° 35′. The latter were collected by the late Col. A. J. Grayson, and the former by Dr. Cooper. Captain Bendire's specimen, which is an adult in fine plumage, was shot April 20, 1872, on the Rillito creek. There are no measurements or other notes accompanying it. Accompanying these specimens is an adult male of *Asturina nitida*, var. *plagiata*, shot on the Rillito creek, May 30, 1872. This specimen possesses peculiar interest from the fact of being the first specimen received at the National Museum from any portion of the United States, though its occurrence within our limits was previously noted, upon the strength of a specimen observed by me in August, 1871, in Richland Co., Illinois (see AMERICAN NATURALIST, vii, April, 1873).—ROBERT RIDGWAY.

AVIFAUNA OF COLORADO AND WYOMING.—Our genial critic (AMER. NAT., vii, 631) unintentionally misconstrues the sentence of ours which he selects as a point of attack. We said, in illustration of a stricture we passed upon the paper he edited, that "such birds as *Geococcyx Californianus* and *Pipilo mesoleucus* find themselves in ornithological company they never saw outside of a book." Dr. Brewer makes us out to mean by this, that *these two* birds are not found together except on his list, and then proceeds to rebuke our supposed ignorance in a kindly and cogent way. But we lived a long while where these two species occur together, and were perfectly aware of such occurrences; what we meant was, that these were two birds which were placed on the list among *certain other* species with which they were not elsewhere found associated; thereby demonstrating the point of our objection, namely, the incongruity of the Holden-Aiken list as edited by Dr. Brewer. Thus our criticism remains in force, while the point of Dr. Brewer's reply disappears.—ELLIOTT COUES.

THE OLIVE-SIDED FLYCATCHER.—Mr. Merriam (in your Dec. No.) forgets that this bird was first noticed by Mr. John Bethune, at Mt. Auburn, near Cambridge, Mass. The first specimen that Audubon ever saw was shot by him in company with Nuttall, in this town (Brookline) about 1835. A year or two later I found here the nest, with eggs, and have since seen the species from time to time, generally in secluded woods abounding in pitch-pine, like the once lovely but now desolate spot where it was first discovered.—J. E. CABOT.

A REMARKABLE PECULIARITY OF CENTROCERCUS UROPHASIANUS.—A peculiarity of this species, which I have not seen noticed, is that its stomach, instead of being hard and very muscular as in other Gallinacea, is soft and membraneous, like that of the birds of prey. This was first told me by hunters in Nevada, and I afterwards satisfied myself of the truth of their statement that the sage hen "has no gizzard," by dissecting a sufficient number of individuals. This bird is never known to eat grain, but it subsists almost entirely upon green leaves of Artemisia and on grasshoppers.—ROBERT RIDGWAY.

On a Hummingbird new to our Fauna, with certain other facts ornithological. — The following notes were collected during the past season (1873), in connection with the explorations in charge of Lieut. G. M. Wheeler, and under the auspices of the Engineer Department. They are selected as of especial interest, from a large amount of material to be embodied in a future report.

Eugenes fulgens (Sw). Sp. Char.—Male:—Tail rather deeply emarginated. Head above violet purple. Rest of upper parts bronzed green, becoming pure bronze on the tail. Gorget brilliant emerald green, with strong purple reflections. Lower portion of breast and abdomen opaque black, more velvety towards the green of the throat. Sides of body dull green. Wing above and below dull purple. Upper and lower wing coverts green. Crissum pale brownish gray. Bill and feet black.

Female: Tail double-rounded. Above dark metallic green, each feather edged with ash. Below dull white; feathers of throat and fore part of breast with dull grayish green centres. Sides green edged with ash. Wing dull purple. Each feather of the tail except the two central, which are green throughout, with broad purple bands. Three outer tail feathers broadly tipped with dull white which, on the outer, extends slightly further up on the outer web. Length 4·61; wing 2·43; tail 1·75; bill 1·09.

This fine species has, for the first time, been ascertained to inhabit the United States, it never having been observed before farther north than the table-lands of central Mexico. While at Camp Grant, Arizona, Sept. 24th, I procured a fine female, on a small stream issuing from a mountain cañon. When first seen it was being pursued by another hummer, of which I obtained scarcely a glimpse, as they darted past through the trees, but I have little doubt that it was a second of the same species. I think it not unlikely that this species will be found to be not uncommon in summer, in the mountainous districts in southern Arizona and New Mexico. Here along the streams, where the flora is abundant, the multitude and variety of the hummingbirds, resplendent as they are with the most gorgeous colors, cannot fail to strike the most unobservant eye. In the mountains near Apache, Arizona, two of our species (*Selasphorus rufus* and *S. platycercus*) are found in almost incredible numbers, bringing forcibly to mind the accounts of the abundance of the birds of this family, amidst the tropical vegetation of South America; and it will be strange indeed if a careful search in midsummer, in these localities, does not reveal still other species, which must find, in this semi-tropical climate and flora, a congenial home.

Baird's Bunting (*Centronyx Bairdii* Bd.). The interesting fact of the discovery of Baird's bunting, in large numbers in northern Dakota, by Dr. Coues, was announced in the November Naturalist. Additional light is thrown upon the range of this hitherto almost unknown species, by its discovery in southeastern Arizona and southwestern New Mexico. I found it in immense numbers, from Sept. 20th till late in October, throughout the rolling plains along the bases of the mountains, and even quite high up among the foot-hills. It was usually associated with the savanna and yellow-winged sparrows, and seems to embrace in its habits certain characteristics of either species. Its flight is particularly like that of the former bird, but even more wild and irregular. It pursues its zigzag course for a couple of hundred yards, and then, suddenly turning sharply to one side, alights behind some friendly bush, or tuft of grass. Like the yellow-winged sparrow, it is difficult to flush, but seeks rather to evade search by running nimbly through the grass, changing its course frequently, and hiding wherever possible, flying only when hard pressed. A large number of specimens were secured, all moulting, and many in extremely ragged plumage; from their condition it is presumed that they were not migrants, but breed in the immediate locality.

BLACK-BREASTED WOODPECKER (*Sphyrapicus thyroideus* Bd.). This species was first made known to science through a description by Cassin, published in Dec., 1851, in Pr. A. N. Sc. In 1857, Dr. Newberry published a description of Williamson's woodpecker (*S. Williamsoni*) from specimens obtained by Lieut. Williamson's Expedition: since which time the two species have been accepted by ornithologists as perfectly valid, the true relationship of the two being wholly unsuspected. While in southern Colorado during the past season, I obtained abundant proof of the specific identity of the two birds in question, *Williamsonii* being the male of *thyroideus*. Though led to suspect this, from finding the two birds in suspicious proximity, it was some time before I could procure a pair actually mated. After careful search I discovered a nest excavated in the trunk of a live aspen (*Populus tremuloides*), and both the parent birds were secured as they flew from the hole, having just entered with food for the newly hatched young. As regards the sexual differences of coloration, the case of *thyroideus* is wholly unique. In this species, the colors of the female are radically different from those of the male. With this single exception as far as known, the differences of color between the sexes, in the family of woodpeckers, are confined mainly to the absence, or less amount, of the bright crimson or red patches about the head.

Eared Grebe (*Podiceps auritus* var. *Californicus* Coues). In a series of alkali lakes about thirty miles northwest of Ft. Garland, southern Colorado, I found this species common and breeding. A colony of perhaps a dozen pairs had established themselves in a small pond of about four or five acres in extent. In the middle of this, in a bed of reeds, were found upward of a dozen nests. These, in each case, merely consisted of a slightly hollowed pile of decaying weeds and rushes, four or five inches in diameter, and scarcely raised above the surface of the water, upon which they floated. In a number of instances they were but a few feet distant from the nests of the coot (*Fulica Americana*) which abounded. Every grebe's nest discovered contained three eggs, which in most instances were fresh; but in some nests were considerably advanced. These vary but little in shape, are considerably elongated, one end being slightly more pointed than the other. They vary in length from 1·70 to 1·80 and in breadth from 1·18 to 1·33. The color is a faint yellowish white, usually much stained from contact with the nest. The texture is generally quite smooth, in some roughened by a chalky deposit. The eggs were wholly concealed from view by a pile of weeds and other vegetable material laid across. That they were thus carefully covered, merely for concealment, I cannot think, since in the isolated position in which these nests are usually found, the bird has no enemy against which such precaution would avail. On first approaching the locality the grebes were all congregated at the further end of the pond, and shortly betook themselves through an opening to the neighbouring slough; nor so far as I could ascertain did they again approach the nests during my stay of three days. Is it not then possible that they are more or less dependent for the hatching of their eggs, upon the artificial heat induced by the decaying vegetable substances of which the nests are wholly composed?—H. W. Henshaw.

Occurrence of Telea polyphemus in California.— A correction. — On p. 454, vol. vii, of this journal, and on p. 15 of the "Proceedings of the Boston Society of Natural History," xvi, I state that *Telea polyphemus*, the American silk worm, does not occur in the Pacific states. It seems that Mr. Henry Edwards, in an interesting paper published in the "Proceedings of the California Academy of Sciences" (received Dec. 11, after my second paper went to press) records this moth as "apparently not rare in Vancouver island. . . . . . This insect, though one of our Pacific coast varieties, has nevertheless a wide range. I have seen specimens from Victoria, northern and middle California, San Diego, cape St. Lucas, and San Blas, Mexico."

On pp. 24 and 40, Bost. Proc., xvi, *Gorytodes uncanaria* Guen. should read *Platœa Californiaria H.-Sch.* and *Gorytodes trilinearia* should read *Platœa trilinearia.* — A. S. PACKARD, Jr.

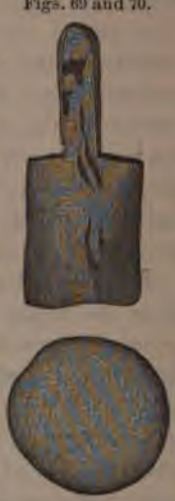
IDENTITY OF OUR HYDRA WITH EUROPEAN SPECIES.—At a late meeting of the Academy of Natural Sciences of Philadelphia, Prof. Leidy made some remarks on our native *Hydra*, and described the common green and brown species. He stated that they had been regarded as distinct species from the green and brown ones of Europe, but he could perceive no difference. He described the habits of some of our *Rhizopoda* in eating *Diatomaceæ;* they absorb the chlorophyl and reject the silicious shell. *Amœba* devours *Arcella.*

GEOLOGY.

THE GREAT LAVA-FLOOD OF THE WEST. — Prof. J. LeConte describes in the March number of the "American Journal of Science," what he regards as the most extraordinary lava-flood in the world. "Commencing in middle California as separate streams, in northern California it becomes a flood flowing over and completely mantling the smaller inequalities, and flowing around the greater inequalities of surface, while in northern Oregon and Washington it becomes an absolutely universal flood, beneath which the whole original face of the country, with its hills and dales, mountains and valleys, lies buried several thousand feet. It covers the greater portion of northern California and northwestern Nevada, nearly the whole of Oregon, Washington and Idaho, and runs far into Montana on the east and British Columbia on the north." Its extent "cannot be less than two hundred thousand to three hundred thousand square miles, *i. e.*, greater than the whole area of France, or nearly double the area of California." He believes the mass of lava to have issued from fissures, some in the Coast Ranges, but mostly in the Cascade and Blue Mountain Ranges. This flood began, probably after the miocene tertiary period and continued until the post-tertiary. When the fissure eruptions had finally ceased, the work was taken up by volcanoes, a few of which are still active. The paper is one of much interest.

ANTHROPOLOGY.

Figs. 69 and 70.



The Manufacture of Pottery by the Indians. — Among the Indians, the women are the makers of pottery, the men looking upon it as degrading to do "squaw work." Two implements only are used in its construction; one is a wooden paddle (fig. 69), the other a flattened round stone (fig. 70). The figures here given are very much reduced in size. These implements are made by the women with much labor and are considered as valuable and essential household articles. In earlier times when they had nothing but stone tools with which to shape them the labor must have been immense.

After the clay has been properly mixed with water, and kneaded with the hands and the wooden paddle until it is of a proper consistency, a portion is taken and placed over the flat part of the stone and made smooth and even by rapid pats with the paddle. The clay is then placed on a smooth spot on the ground with the stone above it and the bottom of the utensil is thus formed. A piece of clay is now taken in the hands and rolled out to the proper length; it is then placed around the stone in connection with the other piece and the stone is moved about on the inside while with hand and paddle on the outside the roll of clay is flattened out and firmly united with the first piece. More is then added in the same manner and so on until the desired size is attained. The hands are often dipped in water during the operation in order to keep the clay moist; and the stone and hand are used to smooth the inside. The necessary height being attained, the rim is formed by pressing the top layer of the soft clay over the round edge of the stone, the fingers pressing the clay over while the stone is moved round the vessel. If feet or handles are to be applied, they are shaped by the fingers and stuck on; the hand is now freely used to smooth over the newly made vessel. The pot is then placed in the sun and constantly turned so as to expose it evenly to the heat. When cracks appear, the fingers are dipped into thick mud and applied to them, which process is continued until all the cracks are filled after which the vessel is ready to burn. For this purpose fuel is selected which produces a gentle heat, the excrements of animals being preferred. All the Pueblo Indians of New Mexico and the Moquies of Arizona own many sheep and goats which for safety are put into pens at night; consequently a great thickness of excrement is soon accumulated. This is cut into pieces and dried in the sun for fuel in their dwellings and for burning pottery. For the latter purpose a quantity is set on fire and as soon as sufficiently burnt, some is put inside the vessel while the rest is piled round the sides and the vessel is left in this burning mass to bake, which is done very evenly. If the vessel is to be glazed it is done, after being removed from the fire but while very hot, by rubbing over it very strong salt water and again exposing it to the heat.

The ornamentation is done before burning and immediately after the vessel ceases to crack by exposure to the sun. This generally consists of simple, parallel lines and indentations (the fingers and a stick being the only instruments used to form the required devices). If the vessel is to be colored it is done by dissolving clay of the desired color in water; a brush is formed by chewing the end of a stick, which is then dipped into the coloring matter and applied to form the ornamentation, both lines and figures being made. The vessel is now allowed to dry thoroughly, after which it is burned in the same manner as plain pottery. Sometimes vessels are uniformly colored inside and out; often only the outside is colored, with no other ornamentation. The colors generally used are orange, red, black, slate, white, brown and yellow.

The quality of the clay determines the kind of vessel that is to be made. For a cooking utensil coarse clay is used, often mixed with very fine gravel; this quality stands heat better than the finer clay which is used in making the choicer grades of pottery.

The mode of manufacturing pottery here described is that of the Indians of Arizona, New Mexico, California and Utah at the present day, and when these Indians find a profitable market for their wares they make articles not to be despised by their white friends.

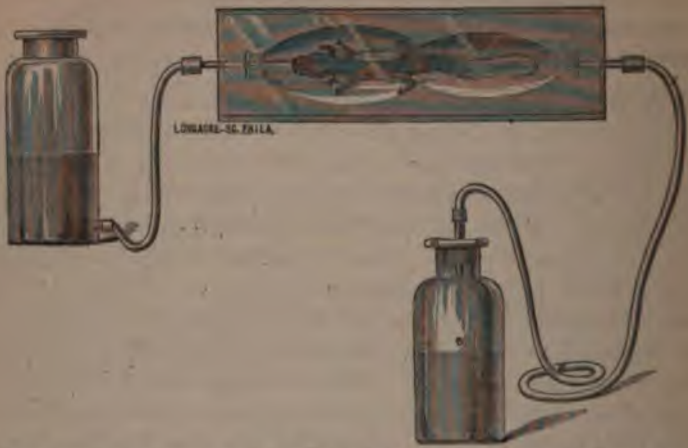
In many ancient burying mounds round stones have been found; these were evidently used in making pottery, the wooden paddles which were probably placed with them having decayed. There is no difference between the modern article and these ancient stones found in the graves associated with pottery and other domestic articles buried with the dead.—EDWARD PALMER.

THE BERRIES OF RHAMNUS CROCEUS AS INDIAN FOOD.—This is a fine evergreen, producing numerous red berries which render it very showy. The Apaches collect and pound them up with whatever animal substances may be on hand, the berries imparting to the mixture a bright red color which is absorbed into the circulation and tinges the skin. On one occasion a detachment of the First Arizona Infantry Volunteers attacked a camp of Apaches in the Mogollon Mountains, northern Arizona, killed twenty-two and captured two children; the writer, being with the party as surgeon, examined the dead; their abdomens were much distended from eating greedily of these berries and other coarse substances; while their bodies exhibited a beautiful red net-work, the coloring matter having been taken up by the blood and diffused through the smaller veins. Among the captured stores were quantities of these berries dried, also much finely pounded meat and berries. A stone mortar, near by, plainly told the purpose for which it had been used; while numbers of rats and squirrels with the fur singed off, but otherwise entire, lay ready to form the next batch of mixed meat and berries. These Indians are not dainty, for they relish any part of an animal, even its viscera and blood.—EDWARD PALMER.

MICROSCOPY.

HOLMAN'S SIPHON SLIDE.—Mr. D. S. Holman of Philadelphia, whose life slide has recently become a really useful as well as a popular accessory to the microscope, has contrived a modification of that accessory to be known as the siphon slide, in which living objects of suitable size and habits can be retained under observation uninterruptedly for days or even weeks. A current of water or other fluid, of any required temperature, is made to flow continuously through the chamber containing the object, so that the processes of respiration, circulation, digestion, and nutrition, the phenomena of inflammation, and the effects of some classes of poisons may be studied at leisure and under perfectly natural or entirely controllable conditions. The habits of life of small aquatic animals are similarly brought within reach of our observations. For the following cut and description of this valuable contrivance we are indebted to the courtesy of the editor of the "Journal of the Franklin Institute."

Fig. 71.



"This invention presents a modification of the chamber of Mr. Holman's former device, known as the 'Life Slide.' It has fine perforations at each end of the chamber, too small to permit the escape of the animal under view, but sufficient to maintain a flow of water. These openings merge into cylindrical mouths, at each of which is attached a tightly-fitting elastic tube: one of these communicates with the reservoir of water, while the other acts as an escape conduit. The position of the slide, when in use, must be slightly *above* the level of the reservoir, while the escaping tube must rest *below* the reservoir; thus insuring a veritable siphon action in the apparatus, a constant flow of water being thus secured, in connection with the required atmospheric pressure for the retention of the cover of the slide. By this ingenious device, living aquatic animals may be retained in the chamber in a natural condition for hours, and even days."

STRUCTURE OF THE POTATO.—Mr. Thomas Taylor explains in a recent article that the vascular bundles in a potato may be easily seen by cutting a potato in two through its axis, the section also passing through some of its eyes, and coating the cut surface first with a solution of bichromate of potash and afterward several times with a strong tincture of iodine which will stain the starch blue but leave the vascular bundles yellow. The air-ducts will then be seen to extend invariably to the eyes.

For microscopical study thin sections are to be made and treated with a strong acid or caustic alkaline solution which will dissolve the starch but leave the vascular bundles unaltered. The sections may then be mounted as usual.

To isolate the vascular bundles place a potato, skinned without wounding the eyes, in a solution of sugar and water (two ounces to the pint) and keep it at a temperature of 75° F. for nearly two weeks. The fungus of fermentation will reduce the potato to a pulp, except the vascular bundles which may be mounted in gum or balsam and studied with a power of one hundred diameters. They constitute a beautiful object, the pointed forms leading toward the eyes being distinctly seen.

He notices that different varieties of potatoes are affected in a widely different manner by the potato-rot fungus (*Peronospora infestans*), the Jackson White, for instance, being unaffected when the Early Rose growing in the same field were wholly destroyed by fungi. He believes it probable that, other things being equal, those varieties of potatoes which have the smallest air passages will be least affected by the fungus. The Santa Fé potatoes resisted fungoid and infusorial action far better than any other varieties tested, and it is claimed that they also, when growing in the field, resist the "rot" which destroys the varieties commonly cultivated in this country.

MICROSCOPIC DRAWING. — Wishing to make a neutral tint reflector, and while planning a frame in which to mount it, it occurred to me that a reflector to take the place of the steel disk of Soemmering might be made by mounting a piece of looking-glass in the same way as a neutral tint reflector, but with the silvering removed except a small disk less than the size of the pupil. On trial I found the reflection good, but the thickness of the glass looked through in such an oblique position tinted the field. In order to avoid this I made a mirror with a small disk of tin-foil wet with mercury and placed on the centre of a thin glass cover. This I mounted as before, and found it to work perfectly. This little contrivance which can be made by any one of ordinary mechanical ability will take the place perfectly of the expensive camera lucida.

I made another, using wood in place of brass. I centred a piece of wood and turned a place for the cap end of the ocular and a smaller hole the rest of the distance through the bit of wood; turned the outside in the form of a cylinder and sawed off the end in a mitre-box to an angle of forty-five degrees; then bored a one-half inch hole near the end of the tube for the reflected rays, and turned a disk with a cell for the mirror and fitted the thin glass, keeping it in with a small ring of wood glued over the edge of the glass. The microscope being arranged for drawing and an object focussed, this tube was adjusted and the oblique end smeared with glue; then the disk was fitted to the end of the tube in such a manner that the bit of mirror was in its optical axis. After the glue was dry the projecting edge of the disk was removed and the eye end of the apparatus cut down so that the eye might approach the reflecting surface. This works nicely, and is much more easily made than the brass mounting.—F. B. KIMBALL, M.D.

AIR-CELLS IN A FLOATING LEAF.—In the leaf of *Limnanthemum lacunosum*, or floating-heart, may be demonstrated multitudes of peculiar stellate bodies, apparently like those found in the stem of *Nuphar*. The whole interior of the leaf is studded with them. There are no ordinary large air-spaces so often found in other floating leaves, but all through the parenchyma these curious bodies are irregularly scattered.

They vary in size and also in the number of rays given off by each. These rays are smooth and not echinulate like those in *Nuphar*. In the field of a ⅔ lens I have counted hundreds at one view. Under the polarizing binocular microscope properly illuminated, they are revealed with startling distinctness and beauty.

It is nearest the under epidermis that they are located, and the best view therefore is obtained from beneath. Their true physiological significance is not doubtful. In the natural condition they contain air, and the floating-heart rides securely on the surface of the lake, buoyed up by innumerable life-preservers which are not likely to shift out of place.

The veins in the leaf are present, of course, but are comparatively rudimentary. The vascular bundles are faintly marked, and only a few delicate supporting cells line their margins; thus giving another example of nature's economy, for where strongly developed organs are not necessary there we do not find them. — J. G. HUNT, M.D.

LIFE OF HÆMATOZOA. — Francis H. Welch describes in the "Monthly Microscopical Journal" a thread-worm (*Filaria immitis*), infesting the vascular system of the dog, and thus theorizes as to the method by which such parasites, which are now doubly interesting from having been recently discovered in human blood, may effect an entrance into the system. "The faculty of migration of the white corpuscles of the blood through the tissues of the body has been demonstrated; the diameter of the body of the young filaria is considerably below that of the corpuscle; hence with the brisk, wriggling movements of life, the possibility of their passage through a mucous membrane, especially through the soft granulations of an ulcer, is quite within the bounds of reality. Based upon the facts we know, we may in imagination follow them from a mucous tract (*e. g.* the intestine) to a lacteal or blood vessel; they follow the course of the circulation, growing on the pabulum of the blood of the host, and easily passing with the corpuscles through the capillaries; soon their size unfits them to traverse every viscus, and the minute capillaries of the lungs act as a sieve to retain them in the venous circulation; they copulate and the females become fecund; a young brood arises to continue the race, provided accidental causes, such as mechanical blocking up of important blood-vessels by the parent worm, do not determine the death of the host. By this hypothesis the ingress of individuals capable of arriving at maturity is explained, while the countless hordes of young are rendered lucid only by the presence of one or more parent worms within the vascular walls. These parent worms after producing their progeny may possibly die and disintegrate, and so account for their absence, or non-discovery, in hosts teeming with the young brood." The presence of the parent worm is attributed suggestively to the ingestion of water or under-cooked flesh containing them.

FINDING THE CHEMICAL FOCUS IN PHOTOMICROGRAPHY.—Prof. H. A. Rowland has suggested, at the Troy Scientific Association, the simple expedient of laying a broad flat object, as for instance a microphotograph or a large transparent section, obliquely upon the stage, so that one edge shall be considerably higher than the other. The objective is then carefully focussed for some one well-marked portion of the object, and a photograph taken which will of course show the best definition at some other portion. The instrument is next focussed for the point in the object which in the photograph is best defined, and the distance apart of these two planes, measured by the fine adjustment wheel, being the distance of the chemical from the visual focus, is a correction which may always be employed in photographing with the same objective, the lens being focussed as usual by sight and then turned out of focus the required distance. This method is applicable to the lower powers, and is for them far preferable to the usual procedure of guessing at the amount of correction required and taking a series of photographs to determine which is the most successful correction.

A SPHERICAL DIAPHRAGM.—Wishing to use tubular diaphragms with my microscope, and knowing how clumsy the ordinary ones are, I set to work, and endeavored to devise a substitute. I made a globe one and one-fourth inches in diameter and drilled holes through it of the proper grade of sizes, and adjusted it so that by a spring stop the holes will correspond to the axis of the microscope when the ball is revolved on its axis by a milled head at the right of the stage. The fittings are so arranged that the diaphragm may approach or recede from the stage so as to touch the slide or be far from it. The globe may be made hollow and the lower part cut off if the tubular wells are not desired. I think this form of diaphragm offers many advantages over the ordinary piece of apparatus.—F. B. KIMBALL.

LEAF SECTIONS.—Mr. Charles Stewart obtains sections of fresh leaves by inserting a piece of the leaf in a notch cut in a carrot and cutting slices through both carrot and leaf. The sections are then soaked in water in a watch-glass under an exhausted receiver, stained with hæmatoxylin, and transferred through water, absolute alcohol and oil of cloves to the mounting medium. In the oil of cloves they would curl up were they not prevented by a heavy cover glass laid upon them.

ANOTHER ERECTOR.—John A. Perry, of Liverpool, recommends an objective, inverted, above the eye-piece as an erector. With a 1 inch working objective and A ocular, a ½ or ¼ objective may be inverted and stood upon the cap of the ocular, giving an increase of power and of working distance as well as an erect image. [A ½ objective supported on an adapter two inches long seems to perform as well as any; but the inconveniences of the method seem to be too great for its advantages.]

CEMENTS.—Mr. F. Kitton prefers, for making varnish cells, asphalte with the addition of a small quantity of gold size; the cells when finished being dried over night in a cool oven. For mixing colors with, he prefers dammar cement with a few drops of gold size; the exterior ring being of vermilion or purple lake, and the interior ring white zinc in preference to white lead. Sealing wax varnish he does not trust.

Auto-microscopy.—Dr. Otto Obermier, who died of cholera at Berlin a few months since at the age of thirty-one, deserves to be remembered as the first microscopist, probably, who continued his studies in pathology by the study of his own blood during the progress of the disease of which he died; the disease having been contracted, also, by imprudent devotion to its investigation.

Measuring the growth-rate of Plants.—E. Askenasy measures with a micrometer the advance of the growing point of a root or branch in a glass tube in the field of the microscope. The stem is fixed by cork or other means at one end of the tube, and the conditions of light, temperature and moisture are easily regulated.

A Revolving Amplifier.—Mr. John Emery exhibited, at the Royal Microscopical Society, a series of amplifiers, plano-concave lenses of different foci, arranged in a metallic disk which revolves so as to bring any desired lens within the body of the microscope.

Quieting Frogs.—At the Medical Microscopical Society, Dr. Bruce stated that a frog might be quieted, for experiment oh the circulation, etc., by holding for a few minutes in the hand, as well as by the usual plan of immersing in warm water.

NOTES.

Lt. G. W. Wheeler's Expedition, for the Survey of the Territories west of the 100th meridian, has lately returned to Washington to elaborate the results of the last season's work in the field. A very extensive ground in Colorado, Utah, New Mexico and Arizona was thoroughly gone over, and large collections were made by the naturalists of the expedition in all departments of zoology, as well as in botany and geology. The suite of birds is particularly large and valuable, embracing many rarities and desiderata. Too much credit cannot be given to Mr. H. W. Henshaw for his indefatigable exertions in this department. His skins are in admirable preservation, and form one of the most valuable lots ever brought from the West. The birds and mammals will be elaborated by Mr. Henshaw, in connection with Dr. H. C. Yarrow, a well-known and accomplished naturalist. The collection of reptiles, fishes and insects is large; these objects will severally be placed in the hands of the most competent specialists for elaboration. Among the *Orthoptera*, it may be observed, many of Haldemann's little known or lost species are recovered. There is a valuable collection of crania, implements and other ethnological material. The field work in Natural History of 1873 was accomplished by Mr. Henshaw, with Dr. Rothrock, the talented young botanist, Dr. Newberry, Jr., and Dr. Loew. Next season, the same department will be placed entirely in the charge of Dr. Yarrow, who will be assisted by Dr. Rothrock, Mr. Henshaw and others. We shall look for still more interesting results under this excellent arrangement. We learn that seven volumes showing the progress of the work thus far, and beautifully illustrated, are now being arranged for the printer. Every naturalist will join us in hoping that the good work may be successfully prosecuted, and in trusting that the appropriations necessary to this end may be made by Congress.

THE annual social meeting of the Troy Scientific Association was held Jan. 19th, at the residence of Dr. Ward, on Fourth street. Notwithstanding the inclemency of the weather the attendance was good, nearly one hundred being present, and half of that number ladies. Among the gentlemen present were noticed Rev. Dr. Robinson, Rev. Dr. Irvin, Rev. Mr. Hervey, Rev. Mr. Young, and many other leading citizens. After a talk of about two hours, the election of officers for the ensuing year was proceeded with. Prof. Beattie read the report of the committee on nominations, which recommended the election of the following gentlemen: President, Dr. R. H. Ward; First Vice President, Rev. A. B. Hervey; second do., Rev. Wm. Irvin; Corresponding Secretary, F. H. Stevens; Recording Secretary, Prof. A. E. Bower; Treasurer, Prof. David Beattie. On motion the report was accepted and the parties above named duly elected. The following persons were elected members of the Association; resident members, Francis O. Dorr, of Troy, and Albert E. Powers, of Lansingburg; corresponding member, John Jones, of Rensselaerville, N. Y. After the election and other formal business had been transacted the company repaired to the dining room, and were hospitably entertained.

THE Rev. John Bachman of Charleston, S. C., died on Feb. 25th, at the venerable age of 85. This eminent naturalist and theologian was a native of New York, having been born in Dutchess county, Feb. 4, 1790. He joined the ministry of the Lutheran Church in 1813, and in 1815 became pastor of the German Church of that denomination in Charleston, S. C., retaining that office until his death. He was an associate of Audubon, whom he assisted in the preparation of his great work on Ornithology, and was the principal author of the three volumes on the quadrupeds of North America, illustrated by that great naturalist and his sons. Bachman also published other works and about fifteen minor papers, all evincing unusual powers of observation, especially those on change of color in birds, on the migration of birds, on the mode of reproduction of the opossum, and several anthropological papers.

THE Legislature of Kentucky have appropriated $18,500, annually, for two years, for a new geological survey of the state. Prof. N. S. Shaler is appointed state geologist.

Is not the time coming for a careful geological and zoological survey of the state of Massachusetts? While surveys are going on or have recently been completed in so many other states, it is not particularly to the credit of this state that a thorough survey of its geological and biological riches has not been instituted. It is now over thirty years since the original incomplete survey of the state was made. Since then physical science has changed so much that the work done then needs to be reviewed and greatly extended.

THE enterprising city of Waterbury is to be congratulated on the possession of a score or more of gentlemen, associated as the Waterbury Scientific Society, who have been endeavoring for several years, by popular lectures and other means, to attract the more intelligent of their fellow-citizens to the improvement and development of their minds by the beginnings of scientific research. It is not often that any except a college town has so many men who are earnest students in special fields of knowledge, and who have made so much attainment in their specialties.—*Hartford Courant.*

A MICROSCOPICAL Society has been formed at Louisville, Kentucky, which meets the first and third Thursdays of each month.

The following are the names of the officers for the ensuing year: President, J. Lawrence Smith; Vice Presidents, Noble Butler, Chas. F. Carpenter; Treasurer, C. T. F. Allen; Cor. Sec'y, E. S. Crosier; Secretary, John Williamson; Executive Committee, Thos. E. Jenkins, James Knapp, W. T. Beach, E. R. Palmer, R. C. Gwathmey.

THE Maryland Academy of Sciences have recently built a new hall for a museum 30×70 feet, by 20 feet high. It is proposed to arrange in it a biological collection of the objects chiefly representative of the regions of which Maryland forms a part.

EXCHANGES.

Slides of Diatoms arranged in groups, offered for other mounted microscopic specimens.—W. W. RINER, Greene, Butler Co., Iowa.

W. M. WILSON would like to correspond with two or three young botanists for the purpose of exchanging Rocky Mountain specimens for eastern species of plants.

BOOKS RECEIVED.

Tidskrift for Populære Fremstillinger af Naturvidenskaben. 8vo, Vol. v, Part 1. Copenhagen, 1873.

Proceedings Philadelphia Academy of Natural Sciences. 8vo, sig. 27, 1873.

Notice of New Equine Mammals from the Tertiary Formation. By O. C. Marsh. Received Feb. 28, 1874. 8vo, pp. 12. (From Am. Jour. Sci. and Arts, Vol. vii, March, 1874.)

Reports on the Geological Survey of the State of Missouri. 1855-1871. 8vo, pp. 323. With maps, plates and woodcuts. Jefferson City, 1873.

Geological Survey of Missouri. Preliminary Report on the Iron Ores and Coal Fields from the Field Work of 1872. 8vo, pp. 655. 190 Illustrations in the text and an atlas. New York, 1873.

Entomologische Zeitung. Jahrgang 34. Stettin, 1873.

Bulletin Meteorologique Mensuel de l'Observatoire de l'Universite d'Upsal. 4to, Vol. iv. Nos. 1-12, Dec. 1871-Nov. 1872. Vol. v, Nos. 1-6, Dec. 1872-May 1873. Upsal.

Nova Acta Regiæ Societatis Scientarum Upsaliensis. 4to, series 3, Vol. viii, Part 2, 7 plates. Upsal, 1873.

Memoires de la Societe de Physique et d' Histoire Naturelle de Geneve. 4to, Tome xxiii, Part 1, Plates 8-10. Geneve, 1873.

Berliner Entomologischer Zeitschrift. 8vo, Jahrgang 17. Pts. 1 and 2. Berlin, 1873.

Transactions of the Imperial Botanical Garden of St. Petersburg. 8vo, Tome ii, Part 2. St. Petersburg, 1873.

Vierter Bericht der Naturwissenschaften Gesellschaft zu Chemnitz. 8vo. Jan. 1, 1871-Dec. 31, 1872. Chemnitz, 1873.

Verhandlungen des Naturhistorischen Vereines der preussischen Rheinlande und Westphalens. 8vo, Jahrgang 29, Part 2, 1872. Jahrgang 30, Part 1, 1873. Bonn.

Achtundfunfzigster Jahresbericht der Naturforschenden Gesellschaft in Emden. 8vo. Emden, 1872.

Bulletin de la Societe des Sciences Naturelles de Neuchatel. Tome ix, Part iii, 8vo, 3 plates. Neuchatel, 1873.

Bulletin de la Societe Imperiale des Naturalistes de Moscou. 8vo, Plates 3-6. No. 2, 1873. Moscow.

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. 8vo, Band lxvi, Parts 1, 2, 3. Hefte 1-5, 1872. Band lxvii, Part 1, Hefte 1-5, Part 2, Hefte 1-3, 1873. With plates. Wien.

Dictionary of Elevations and Climatic Register of the United States. By J. M. Toner. 8vo, pp. 95. D Van Nostrand, Publisher. New York, 1874.

Elements of Zoology. By M. Harbison. 12mo, pp. 172. G. P. Putnam's Sons, Publishers. New York, 1874.

Notes upon the Fossil Remains of the Lower Carboniferous Limestone Exposed at Grand Rapids, Mich. By E. A. Strong. 8vo, pp. 6. No. 3 of Miscellaneous Papers of the Kent Scientific Institute

Astronomical and Meteorological Observations made during the year 1871, *at the U. S. Naval Observatory.* 4to, pp. 984. Washington, 1873.

Twenty-first Annual Report of the Secretary of the Mass. Board of Agriculture, with an Appendix. 8vo, pp. 620. Boston, 1874.

Notes on Microscopic Crystals included in some Minerals. Two papers, with one plate. *Descriptions of new Species of Unionidæ, etc.* 6 papers. By Isaac Lea. 8vo, pp. 24. (From Proc. Acad. Nat. Sci., Philadelphia.) 1874.

Bulletino della Societa Entomologica Italiana. Anno Quinto. Trimestre IV. 8vo. Firenze. 1874.

THE

AMERICAN NATURALIST.

Vol. VIII.—MAY, 1874.—No. 5.

THE NATURAL HISTORY OF A POLYMORPHIC BUTTERFLY.[*]

BY SAMUEL H. SCUDDER.

THIS butterfly (*Iphiclides Ajax*) occurs east of the great plains, in the Carolinian and the southern half of the Alleghanian fauna; it extends north almost to the annual isotherm of 50°, even passing that line in the region of the great lakes, so as to include southern Michigan and the whole of Ohio, but, apparently, not following the upward curve of the isotherm beyond the Mississippi. In the south it reaches the gulf coast, but how far it extends down the Florida peninsula is undetermined; its western extension is unknown; it has been reported neither from Texas nor Arkansas, although it is common in Missouri (Riley). Prof. Parker states that it occurs on the Mississippi at least as far north as Rock Island, Ill., and that he has taken a few specimens at Keokuk and Davenport, Iowa, although none at Grinnell. It occurs in southern Michigan (Mus. Mich. Univ., Andrews) and in many localities in Ohio, such as Cleveland—"not uncommon"(Kirtland); "common where papaw bushes are" (Kirkpatrick); Columbus, "still more abundant" than at Cleveland (Kirtland); Rockport, Poland and Hudson (Kirtland) and Eastern Ohio (Foster); a single specimen has been reported from Komoka, Ontario, Canada (Saunders). In

---

[*] This article is an extract from the chapter upon *Papilio Ajax* in Mr. Scudder's forthcoming work upon the Butterflies of New England and the adjoining regions; this will account for the form in which it is here presented.—EDS. NAT.

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

Maryland (Uhler) it is "rare" and about Philadelphia (Blake) it is not common. Finally, one specimen has been taken near Brooklyn, N. Y. (Graef *fide* Akhurst).

As in some other dimorphic species, however, the distribution of the several varieties does not seem to be coextensive with that of the species. Unfortunately, our information here is very meagre, since the polymorphism of the insect has only recently been proved. It is, however, certain that the numerical superiority of the variety Marcellus over Walshii and Telamonides is far greater in the north than in the south; indeed, near the northern limit of the insect's range, Walshii and Telamonides are hardly known, and in extreme northern localities where only a few specimens have been recorded, these have always been Marcellus.

The caterpillar, according to numerous authorities, feeds upon the papaw (*Asimina triloba* Dunal) and, according to Dr. Chapman, upon other species of the same genus such as *A. parviflora* Dunal, *A. grandiflora* Dunal, and *A. pygmæa* Dunal. Boisduval and Le Conte also state that it feeds upon the latter and upon *A. palustris*,—plants belonging to the Anonaceæ or custard-apple family.

Some of the caterpillars, as shown by Mr. Edwards' observations, attain their full growth in twelve days, although others, especially the produce of the form Walshii, require nearly a month. They do not draw the leaves of the plant together like the larvæ of the genera represented by Troilus and Glaucus. They are to be found in every stage "resting on the surfaces of the leaves, and one would suppose they must be nearly exterminated by birds. But like all Papilio larvæ they emit from the head [first thoracic segment], at the same time that they project a Y-shaped tentacle, a peculiarly acrid and sickening odor, which must effectually protect them."* In a letter, Mr. Edwards adds that he does "not believe a starving bird would touch one, the stench being so strong as nearly to turn one's stomach."

Science is deeply indebted to Mr. Edwards, for the thorough manner in which he has worked out the history of this butterfly by careful studies in the field and innumerable experiments. This author has not only indisputably established the identity of two forms previously described as distinct species (though often presumed to be identical), but has proved the existence of a third permanent form and has admirably traced the relations of each form to the others. The account given below is almost entirely based on his observations.

---

* Edwards, Butterflies N. America, part ix.

No histories of butterflies are of deeper interest than those of polymorphic species, whether considered in themselves alone or in the light they are destined to throw upon the origin of species and races, problems which demand the profoundest thought and most conscientious investigation; and since this species is polymorphic in a larger sense than any other American butterfly is known to be, our interest is greatly enhanced.

As hinted above, Ajax appears under three different forms — Walshii, Telamonides and Marcellus, the polymorphism affecting both sexes equally. These forms are shown by Mr. Edwards to produce one another in a complicated manner, but in general the imago exhibits what has been termed seasonal polymorphism; that is, a series of individuals adhering, in all their variations, to several distinct types, each type appearing at a different season of the year from the others; thus Walshii is the early spring type, Telamonides the late spring, and Marcellus the summer and autumn type. Nearly all the butterflies which, in West Virginia, emerge from the chrysalis before the middle of April are Walshii; between that and the end of May, Telamonides; after this, Marcellus. The first two, however, do not appear properly to represent distinct *broods;* and this point (to which Mr. Edwards has failed to draw special attention) is one of the most extraordinary features in the history of the insect; for Telamonides, judging from his recorded observations, is not the direct conseasonal produce of Walshii, but both are solely made up of butterflies which have wintered as chrysalides, those which disclose their inmates earliest producing Walshii, the others, Telamonides; while all butterflies produced from eggs of the same season — and there are several successive broods — belong to Marcellus. Thus, besides the true seasonal dimorphism which distinguishes the butterflies produced from eggs of the same season from those derived from eggs of the previous season, we have a secondary seasonal dimorphism, as it may well be called, separating the earlier from the later produce of wintering chrysalides.

Mr. Edwards has also proved by his experiments that a portion of every brood of chrysalides, instead of disclosing the imago at the end of the ordinary time, retain it, occasionally until the appearance of a subsequent brood, but usually until the next spring. The spring brood (Walshii-Telamonides) is therefore by no means wholly produced from chrysalides of the final brood of Marcellus, but in large measure from those of all the earlier broods, even including the earliest Walshii; the proportion of chrysalides which continue until spring increases as the season advances, Mr. Edwards' statements showing that of those produced from eggs laid in April, more than ten per cent. pass over, those from eggs laid May 1-25 about thirty-five per cent., from that time until the end of June from fifty to sixty per cent. and from those laid in July about seventy per cent. Walshii and Telamonides, then, produce Marcellus the same season, or either Walshii or Telamonides in the spring; Marcellus produces itself the same season, or one of the others in the spring; but neither Walshii nor Telamonides is produced the same season by any of the varieties.*

We will now consider the life-history of Ajax. The insect is multibrooded and winters as a chrysalis. The earliest variety, Walshii, "appears in the Kanawha valley (W. Va.), from the 15th to 20th of March, by which time the peach trees are usually in blossom. On these the females may certainly be found, and a little later, on the apple and in great numbers on the wild plum. The males appear a few days earlier [than the females] and are to be seen by the water-side or upon the road, but rarely upon flowers. The larvæ feed on the papaw, and as this is one of the latest of our trees to put forth its leaves, the butterflies are out at least from two to three weeks, before the young shoots of the food plant are visible. But no sooner do these appear than the females hasten to deposit their eggs."† This is early in April and they continue to lay them until as late as May 23d; the eggs hatch in from seven to eight days and the caterpillars are from twenty-two to twenty-nine days in attaining their growth.

---

* The recorded exceptions to this rule (which serve only to strengthen it) are the following: a Telamonides was captured September 12th, and a Marcellus April 11th; the other exceptions occurred in the course of Mr. Edwards' experiments. This indefatigable worker has traced the history of more than two hundred individuals from egg to butterfly, and of these only two did not follow the usual course; these two belonged to a brood produced from eggs laid by Walshii before the middle of April; sixty individuals completed their transformations the same year; all (excepting a pair of belated Marcellus) hatched between June 1st and 6th; fifty-eight chrysalides produced Marcellus, one Walshii and one Telamonides; so that the solitary specimen of Walshii was far out of season, for Mr. Edwards expressly says: "about the first of June Walshii *disappears*" while the one specimen of Telamonides was certainly much later than usual; and in any case, Walshii should produce neither Walshii nor Telamonides the same season. It must be remembered that similar instances of untimely eclosion are by no means very uncommon among butterflies.

† Edwards, Butterflies of N. America. Unless otherwise stated, all these remarks are based upon Mr. Edwards' observations in W. Virginia.

Telamonides, which, as stated above, is only a later variety of the same brood, "begins to fly some weeks after Walshii, and both forms . . . . are for a time common." Telamonides evidently lays its eggs very soon, for "on dissecting the abdomen of a newly emerged female, the eggs are found to be fully formed though not full-sized. I conclude that they mature with great rapidity because fertile eggs are laid by apparently fresh and uninjured females." Mr. Edwards records eggs laid from May 11th to June 2d; these are hatched much more rapidly than those of Walshii (although they are not always laid later in the season), namely, in from four to five days; the caterpillars, too, mature more quickly, attaining their growth in from fifteen to eighteen days, thus often overtaking their tardier predecessors. "About the first of June Walshii [imago] disappears, and before the end of the month Telamonides also."

Still farther south, it is evident that the apparition of the butterflies is advanced; for in Georgia, Abbot records Walshii as emerging from the chrysalis March 2d, and Dr. Chapman took it in northern Florida, in the latter half of February, 1868 and 1869; late in March he also records the species as "numerous," so we may perhaps fairly surmise that Telamonides appears at this time.

"About the first of June, Marcellus begins to appear and shortly is out in great numbers, continuing to be abundant till last of October." The broods overlap each other so as to be distinguished with difficulty, but it appears that, besides the brood of Walshii-Telamonides already mentioned, there are at least three successive broods of Marcellus.* The larvæ of Telamonides, as we have seen, often overtake the later larvæ of Walshii—the earlier larvæ are by this time (the middle of May) in chrysalis and continue fourteen days; the first brood of Marcellus from these chrysalides, and from those of Telamonides, continues to emerge until at least the ninth of July, or for more than five weeks.† The chrysalides from larvæ of Telamonides hang from eleven to fourteen days, and the time for the completion of their entire cycle is only from thirty to thirty-seven days, which is seldom exceeded by Marcellus (twenty-seven to thirty-eight days), although much quicker than the period of Walshii (forty-three to fifty-one days).

---

* Mr. Edwards' language on this point seems a little vague; he says: "Besides the first brood from Walshii, or Telamonides, there are three successive broods of Marcellus, and the larvæ of the fourth give chrysalides that go over the winter, thus making five broods per year."

† Speaking of a brood of larvæ from eggs of Walshii, reared in 1871, Mr. Edwards says that while the mass of the chrysalides (all of which suspended within a week of

The female of the first brood of Marcellus commences to lay eggs — which, like those of Telamonides, hatch in four or five days — at the very beginning of June, and butterflies produced from them, *i. e.* the second brood of Marcellus, are upon the wing early in July — not only before the butterflies of the previous brood have disappeared, but even before all the chrysalides from eggs of Telamonides have eclosed their butterflies; the attempt to trace the sequence of the broods is, therefore, almost hopelessly bewildering; but it seems probable that the second brood of Marcellus (the third of Ajax) appears in abundance early in July; it is, perhaps, in speaking of the first brood of Marcellus in Alabama, that Gosse says they are "nearly all gone July 1st." These larvæ attain their growth in from twelve to nineteen days, and hang as chrysalides from eleven to fourteen, and it is therefore impossible that there should not be a third brood of Marcellus; that a fourth brood is even at times possible would appear from the fact that the insects continue to change from one stage to another without any apparent regard to the approach of winter, which overtakes many in conditions under which they are obliged to succumb; thus Mr. Riley writes from Missouri: "I have found eggs and larvæ two-thirds grown, as late as the middle of October, when the leaves were almost all fallen; the parent ought to know better if instinct is so infallible." Doubleday remarks that on the Ohio the species was very numerous after the tenth of September; if this is an indication of a new brood in September, and if the second brood of Marcellus appear early in July in this locality also, then the butterflies seen by Doubleday must have been a fourth brood of Marcellus, or the fifth of Ajax. I do not think there is another instance on record of a five-brooded butterfly.

The results reached by Mr. Edwards in his study of this butterfly have recently been the subject of some curious comments by

---

each other) eclosed the butterflies between June 1st and 6th, yet "on 23d June, full three weeks after its period, came another ♀ Marcellus and a second followed on the 12th of July;" but even the latter date is only three days after that of others of this brood (from eggs of Telamonides however), which were but thirty-seven days from egg to butterfly.

Mr. Meldola of England, in a paper upon the "amount of substance waste undergone by insects in the pupal state."*

This writer thinks he has shown that the comparative size of the three forms of Ajax is exactly opposite to what we should expect. In his preliminary general remarks, it is presumed *a priori* that as there is in all insects gain of matter in the larval state, and loss during the pupal, the size of an individual of any given species "would be, *cæteris paribus*, inversely proportional to the ratio of the pupal to the larval period, or directly proportional to the ratio of the larval to the pupal period."

He attempts to test this theory by tabulating the statements of Mr. Edwards concerning the duration of the stages in the different forms of Ajax, and he finds that there is "a relationship but exactly the reverse of that which would be anticipated from the conclusions previously set forth."

Walshii, Telamonides and Marcellus, as we have seen, succeed each other in season; they also increase regularly in size in the same order. The following table represents the duration of the several stages and is taken by Mr. Meldola from Mr. Edwards' work.

NAME OF VARIETY.	EGG.	LARVA.	CHRYSALIS.	TOTAL.
Walshii . . .	7–8 days	22–29 days	14 days	43–51 days
Telamonides	4–5 "	15–18 "	11–14 "	30–37 "
Marcellus . .	4–5 "	12–19 "	11–14 "	27–38 "

The next table is Mr. Meldola's attempted tabulation of the facts, by which he comes to the above conclusion.

NAME OF VARIETY.	RATIO OF MEAN PUPAL TO MEAN LARVAL PERIOD.	RATIO OF MEAN LARVAL TO MEAN PUPAL PERIOD.	MEAN EXPANSE ♂.
Walshii	$\frac{14}{25\cdot5} = 0\cdot549$	$\frac{25\cdot5}{14} = 1\cdot821$	2·70
Telamonides .	$\frac{12\cdot5}{16\cdot5} = 0\cdot757$	$\frac{16\cdot5}{12\cdot5} = 1\cdot320$	3·00
Marcellus . . .	$\frac{12\cdot5}{15\cdot5} = 0\cdot806$	$\frac{15\cdot5}{12\cdot5} = 1\cdot240$	3·35

"It is here seen," says Mr. Meldola, "that the size of the variety is directly instead of inversely proportional to the ratio of the pupal to the larval period, and *vice versâ*." Unfortunately for this conclusion the figures given by Mr. Edwards, or their reduction by Mr. Meldola, refer in each case to the *progeny* of Walshii, Telamonides and Marcellus, and do not bear upon the question at all. In every instance given in the tables, the progeny or resultant is Marcellus. By Mr. Meldola's rule, Walshii and Telamonides, being the produce of wintering chrysalides, should be, as they are, smaller than Marcellus, since the latter is always the result of short-lived, summering chrysalides; unless, however, some unknown factor plays a part, Telamonides should be smaller than Walshii, because produced later in the season from wintering chrysalides; but here the opposite is the case.

---

* Ann. Mag. Nat. Hist., Oct., 1873, p. 301.

The extreme abundance of Ajax is well attested by Edwards, when he says: "at certain seasons it is almost impossible to find a young plant [of papaw] that is free from . . . . eggs and it is easy to collect scores of them."

"The female of Ajax may frequently be seen coursing through the papaw trees which . . . . . cover the lower hillsides, or hovering about the young plants that spring up in the cultivated fields, searching for leaves on which to deposit her eggs. After touching or running over and rejecting several, she finds one suitable to her purpose. Thereupon balancing by the rapid fluttering of her wings, she stands for an instant with legs stretched at full length, perpendicular to the body, and curving down the abdomen until it touches the surface, deposits a single egg; then flies away, presently to alight on a second leaf with like intent. Sometimes the egg is upon the stem, and occasionally on the under side of the leaf, but almost always it is upon the upper side, and but one egg will usually be found on the same leaf. The process of laying continues for several successive days." (Edwards).

Doubleday, speaking in particular of the spring-brood writes:* "I rarely saw it alight on flowers. Now and then it would alight on flowers of *Anona grandiflora* . . . . . its flight low, rapid (not sailing with its wings expanded as *P. Thoas* and others). It flies in and around the low scattered brush wood, by the sides of clearings, old deserted cotton fields, and similar situations, often returning to the same spots; in fact so regular did the round seem to be taken, that I have often waited behind a bush for a few minutes for the return of an individual I had seen pass, and rarely failed by this means to capture it. It is a shy insect and darts out of its course at the least motion." Speaking of the autumn brood, which he considers a distinct species, he adds (*loc. cit.*): "its flight is rather more graceful than that of *P. Ajax* [*i. e.* the spring brood]; it sometimes alights in the muddy places by the roadsides where little streamlets cross, especially during the heat of the day." Kirtland, too, remarks: "these two species are readily recognized by their peculiar mode of flight;"* but Edwards makes no comment upon this point.

---

* Arcana Entomologica, i, 61.

"Many eggs," says Edwards, "are destroyed by insects and spiders. There is a minute scarlet spider scarcely larger than the egg itself, that mounts upon it and from a puncture extracts the contents. I frequently met the shells so despoiled before I discovered the cause, and have since observed the marauder in its operations. I have also lost in a single night, owing as I supposed to crickets, numbers of eggs laid in confinement." Speaking of the caterpillar he says: "I have . . . seen spiders feeding upon them, attacking even the head, and they have other enemies among the insects. They are very little troubled by ichneumon flies in this valley, and I have rarely lost a chrysalis from that cause. Consequently no Papilio is so abundant here throughout the season. I find on breeding them that a considerable percentage of the eggs do not hatch, and that more or less of the larvæ die at every moult, as well as in the effort to change to chrysalides. Multitudes of chrysalides must be destroyed in the winter by birds and mice as they are but imperfectly concealed under stones and roots, or even among the stems of the grasses, so that of the tens of thousands of eggs that are annually deposited, but a very small proportion produce butterflies." The caterpillar is, however, sometimes attacked by *Trogus exesorius* Brullé, the imago of which escapes from the chrysalis by cutting a circular opening, usually through one of the wings.

Desiderata. Although so carefully studied by Mr. Edwards, there are still some points in the history of Ajax which require investigation. The distribution of the insect in the west and of each form throughout its natural range should be more definitely determined. The season of the apparition of the different varieties in the extreme southern states, and of the different broods of Marcellus everywhere, is still unknown and will require careful study;

---

* Trans. Entom. Soc. Lond., n. s. i, 1851, Proc. ci.

but perhaps the most interesting and fruitful investigation will be to follow still further the line of Mr. Edwards' experiments, and study the proportion of chrysalides of each brood which retain their inmates until spring; noting every instance of the partial retention of the chrysalis, to discover to what extent pupæ, apparently destined to hibernate, disclose the butterfly the same season; and, further, to determine whether both Walshii and Telamonides are indifferently produced from any of the broods of the previous year. Mr. Meldola's studies would lead us to conjecture that Walshii is generally produced from the later broods of Marcellus, and Telamonides from the earlier broods of the same, and from Telamonides and Walshii; but Mr. Edwards' experiments show that this is not invariably the case. The postures of the butterfly have not been described.

THE GAME FALCONS OF NEW ENGLAND.
THE SPARROW HAWK.

BY DR. WILLIAM WOOD.

THIS beautiful little hawk has the peculiar markings of the true falcon, and is the smallest and handsomest of the family Falconidæ. It is found all over the continent, and is said to be the most numerous of the hawk family. While this no doubt is the fact, yet in New England it is not common. It is about as rare as the pigeon hawk, but not so irregular in its visitations. I have received only ten specimens in twenty years. Allen in his ornithological notes on the birds of the Great Salt Lake Valley says, "The sparrow hawk was by far the most numerous of the Falconidæ. Thirty were seen in the air at one time near the mouth of Weber Cañon engaged in the capture of the 'hateful' grasshopper, which everywhere filled the air and which seemed at this season to form the principal food of this and other birds." In the southern states where it is very numerous it may be seen about the old fields, orchards and gardens, sitting erect on a fence, stake, mullein stalk, or a dead limb of a tree, watching for small birds, mice, grasshoppers or beetles, upon which it chiefly subsists, seldom committing depredations among the young poultry. When leaving its stand it usually flies low and swiftly, and just before reaching its intended perch rises up with a semicircular sweep, and alights with ease, instantly closing its wings and keeping its balance by the motion of its tail, not using its wings for that purpose, as do most hawks when alighting. They become very much attached to one particular spot and may be seen for weeks and months occupying the same stump or stake. Their flight is usually short and irregular; sometimes hovering for a short time with suspended wings, reconnoitring for prey, and then flying off to another place to renew the same manœuvre. They are easily domesticated. Audubon relates an instance of his taking a young bird and providing it with food until able to hunt for himself, when he let him go. "This proved," says Audubon, "a gratification to both of us. It soon hunted for grasshoppers and other insects, and returning from my walks, I now and then threw up a dead bird high in the air which it never failed to perceive from its stand, and towards which it launched with such quickness as sometimes to catch it before it fell to the ground. To the last he continued kind to me, and never failed to return at night to his favorite roost behind the window shutter. His courageous disposition often amused the family, as he would sail off from his perch and fall on the back of a tame duck which, setting up a loud quack, would waddle off in great alarm with the hawk sticking to her. In attempting to secure a chicken one day, the old hen attacked him with such violence as to cost him his life." When they first appear in the spring, their gyrations and cooings are very amusing. No falling in love at first sight can be more amorous. Audubon has described it so graphically that I venture to quote. "When spring returns, each male bird seeks for its mate, whose coyness is not less innocent than that of the gentle dove. Pursued from place to place, the female at length yields to the importunity of her dear tormentor, when side by side they sail screaming aloud their love notes. With tremulous wings they search for a place in which to deposit their eggs; the birds sit alternately, each feeding the other and watching with silent care. The family resort to the same field, and each chooses his stand, stake or mullein stalk, and together hunt." The sparrow hawk is somewhat dainty, refusing to eat woodpeckers or tainted food, and it is said if it catches a mouse which proves to be lousy and poor, it will leave it and seek another. It nests in hollow trees, frequently occupying an old woodpecker's hole; sometimes, though rarely, it has occupied an old crow's nest, seldom constructing a nest for itself, laying usually four eggs, of very uniform size. By taking one egg of a set from four sets and three states, I find the measurements as follows:

From	Pennsylvania,	long	diam.	1·30.	Short	diam.	1·12.
"	Maine,	"	"	1·33.	"	"	1·13.
"	Connecticut,	"	"	1·30.	"	"	1·13.
"	"			1·38.	"	"	1·15.

The markings are somewhat variable, not any more so, however, than most of the eggs of our hawks. The ground color varies from a cream to a deep buff, blotched with small dark brown or chocolate spots, sometimes quite sparsely, then again almost confluently; occasionally the blotches are quite thick at the large or small end, more commonly the former, and in some instances at both ends with few in the middle. Nuttall claims that this bird "lays from four to five eggs." Dr. Brewer says "its eggs are usually as many as five in number." Audubon says "it lays from five to seven, never less than five." It may in some sections lay that number of eggs, but such has not been my experience in New England, having known of only one set of five taken in this vicinity. One of my collectors found a nest with four eggs in the top of a stump about ten feet from the ground, where it evidently had been broken off by the wind. This nest was composed of grass, and was discovered by the grass protruding through a crack in the stump. Whether the hawk constructed this nest, or whether it had been made by some other bird it is impossible to tell; but, if this hawk constructs no nest as asserted by Dr. Brewer and others, it must have obtained it piratically, as the nest was new. In another instance which occurred in Granby, Conn., the nest was known to have been obtained in this way. A farmer made a dove-house inside of his barn with holes through the sides of the building communicating with it. A pair of doves that had nested there were attacked and killed by a pair of sparrow hawks who took possession of their nest, laid four eggs and commenced to sit. During incubation they found the farmers' chickens very convenient for food—too much so for their own good. Both of the birds I saw after they were killed and their four eggs—two of which are now in my cabinet. The eggs must have been sat upon several days; hence this was a full set. Samuels collected one set of four in Maine, and says in his ornithology "I am inclined to think from what I can learn from collectors and others, that four is the usual number laid by this bird." It is asserted by Audubon and others that the sparrow hawk raises two broods in a season in the southern states. Not having any personal knowledge of the fact, I wrote to my friend, Dr. S. W. Wilson, of Georgia, who is an experienced ornithologist and oologist, relative to this point. He says, that "the assertion of naturalists that birds south raise more than a single brood in the same season is certainly not applicable to the rapacious birds;" and again he says, "This is my experience after many observations, that none of the hawks and allied birds breed more than once during the same season," they begin nesting in Florida in February; in the middle states, in April; in Connecticut, in the latter part of April and the early part of May; in Maine, in May and June. A lad brought me a female sparrow hawk, April 26, 1871, which he shot on an old dead tree where he had seen it for several days. I inquired if he looked for a nest. "Yes," he replied, "I looked the tree all over and saw no nest on it." I told him to examine the holes in the tree. He returned the next day with two fresh eggs of this hawk. The set was incomplete but would have been full by the 1st of May. There is as much uncertainty about the age when this bird arrives at adult plumage as there is about the pigeon hawk's age — probably, three or more years. I do not know whether they nest before arriving at adult plumage. The hawk taken here with eggs, and the pair from Granby with eggs, were adult birds; these are the only specimens that I have received that I knew positively had nested.

Length, 10 to 12 inches — alar extent, 19 to 23 inches.

"Adult: Frontal band and space including the eyes and throat, white, spot on the neck behind, two others on each side of the neck, and line running downwards from before the eye, black. Spot on the top of the head, the neck behind, black; rump and tail light rufous or cinnamon color. Under parts generally a paler shade of the same rufous as the back, frequently nearly white, but sometimes as dark as the upper parts, and always with more or less numerous circular or oblong spots of black. Quills brownish black, with white bars on their inner webs. Tail tipped with white, frequently tinged with rufous and with a broad subterminal band of black, outer frequently white, tinged with ashy and barred with black. Bill light blue, legs yellow. Back generally with transverse stripes of black, but frequently with very few or entirely without; rufous spot on the head, variable in size, and sometimes wanting.

Younger male: Upper parts as above; wing coverts and tail ferrugineous red, with numerous transverse bands of brownish black. Under parts with numerous longitudinal stripes, and on the sides with transverse bands of brownish black, external feathers of the tail palest, broad subterminal band on the tail obscure or wanting.

Young: All the rufous parts of the plumage with wider transverse bands of brownish black; wing coverts dark bluish cinereous, with large circular spots of black; under parts with longitudinal stripes, and large circular spots of black."

NATURE'S MEANS OF LIMITING THE NUMBERS OF INSECTS.

BY A. S. PACKARD, JR.

A FEW hints regarding the natural enemies of our injurious insects are here thrown together in order to call the attention of our naturalists and agriculturists to the subject, and provoke inquiries during the coming summer. There is no more interesting subject to our entomologists and ornithologists, than the relations between birds and insects, while the subject of rearing by the wholesale ichneumon and Tachina flies is of vital importance to agriculture.

In the first place I desire to correct a false impression I may have conveyed in my last entomological report to the Massachusetts Board of Agriculture regarding the relation of birds to the canker worm. I there remark that "it would seem as if the birds did not feed upon it to much extent." Wishing to examine into the matter more closely, I have in lack of observations of my own, availed myself of the knowledge of some of our ornithologists.

I am indebted to Mr. C. J. Maynard of Ipswich for the following information upon the birds which devour the canker worm. He informs me that in the course of his investigations he has opened the stomachs of some three thousand birds.

"In answer to your questions relative to birds eating canker worms and the larvæ of other injurious insects I would say that upon examining my notes, I find that I have taken canker worms from the stomachs of the following species:—red-eyed vireo (*Vireo olivaceus*), song sparrow (*Melospiza melodia*), chickadee (*Parus atricapillus*), scarlet tanager (*Pyranga rubra*), robin (*Turdus migratorius*), black billed cuckoo (*Coccygus erythrophthalmus*), wood pewee (*Contopus vireus*), least pewee (*Empidonax minimus*), Wilson's thrush (*Turdus fuscescens*), black and white creepers (*Mniotilta varia*), blue yellow-backed warbler (*Parula Americana*), Maryland yellow-throat (*Geothlypis trichas*), Nashville warbler (*Helminthophaga ruficapilla*), golden-crowned thrush (*Seiurus aurocapillus*), chestnut-sided warbler (*Dendroica Pensylvanica*), yellow warbler (*D. æstiva*), black and yellow warbler (*D. maculosa*), prairie warbler (*D. discolor*), black-polled warbler (*D. striata*), Canada warbler (*Myiodioctes Canadensis*), redstart (*Setophaga ruticilla*), cedar bird (*Ampelis cedrorum*), cat bird (*Mimus Carolinensis*), purple finch (*Carpodacus purpureus*), white winged crossbill (*Curvirostra leucoptera*), chipping sparrow (*Spizella socialis*), indigo bird (*Cyanospiza cyanea*), red-winged blackbird (*Agelaius phœniceus*), cow blackbird (*Molothrus pecoris*), bob-o-link (*Dolichonyx oryzivorus*), Baltimore oriole (*Icterus Baltimore*).

Possibly this list may be increased. Besides these birds, those species which occur in orchards during autumn and winter, such as the ruby-crowned wren, brown creeper, nuthatches and titmice, doubtless eat largely of the eggs of canker worms and other insects which destroy or injure the trees. Winter birds of the above species which I have shot at this time have their stomachs crammed with insects of some kind.

As I remarked to you the other evening the Baltimore oriole will eat largely of the tent caterpillar, and is the only bird which will do this.

All the thrushes will eat wire worms. The swallows destroy multitudes of dipterous insects (gnats, etc.). In fact to sum the matter up there is scarcely a bird which will not eat largely of insects at certain seasons, when these pests are most abundant.

It is a noticeable fact that many species inhabiting woods and meadows, as may be seen by the list given, leave their usual haunts and visit the fruit trees which are covered with canker worms and largely devour them.

In reference to the currant saw fly worm (*Nematus ventricosus*) I am not certain that I have seen any birds eat them, yet I think the truly insectivorous species will do this."

That the Baltimore oriole sometimes eats large quantities of the American tent caterpillar (*Clisiocampa Americana*), since they have been found in the stomach of this bird by Mr. Maynard, is an interesting fact, for birds as a rule do not relish hairy caterpillars, and the American tent caterpillar is covered with long hairs, though they are not so dense as in some other larvæ. In Europe the closely allied tent caterpillar (*C. neustria*), and those of the *Cnethocampa* and *Liparis chrysorrhœa* are said by Perris and others to be almost untouched by birds. I have been told by Dr. T. M. Brewer of Boston that the English sparrows upon the common devoured all the caterpillars of the tussock moth (*Orgyia*) which were injuring a fine tree. These caterpillars are very hairy, being adorned with pencils and tufts of long hairs.

Mr. John H. Sears, of Danvers, Mass., who has paid much attention to the habits of our birds, informs me that the cuckoo, which breeds near houses, is an exceedingly useful bird, as it devours the canker worms in large numbers. It is well that this should be known, as there is a popular prejudice against this bird, from its habit of sucking the eggs, as well as laying its eggs in the nests, of other birds. Among the birds which he has himself observed in the act of eating canker worms, are the king bird, the Baltimore oriole, the cat bird, the common flycatcher, the least flycatcher or wood pewee, the red eyed vireo and a few other small birds, such as certain warblers and flycatchers. The king bird in the month of May feeds on May beetles, as stated by Mr. J. L. Hersey, in this journal.

I also quote from a letter on the subject, for which I am indebted to Dr. T. M. Brewer:—

"The most noticeable of all the destroyers of the canker worm is the common cedar bird, which devours them to an extent perfectly enormous. Next is the purple grakle which also feeds on them as long as they last. The house pigeon, if in any numbers, is an invaluable bird. See, for instance, a garden corner of Summer and Chestnut streets, Salem, where the pigeons make canker worms a thing unknown. Among the other birds, all excellent so far as they go, are the chipping sparrow, the song sparrow, the purple finch, all the vireos, white-eyed, red-eyed, yellow-throated, solitary and warbling, the king bird, the cat bird, the downy woodpecker the summer yellow bird, Maryland yellow throat, the blue-bird. The bluejay eat their eggs in the winter, so does the chickadee. The latter eats their grub also and the worm too. The common gray creeper, which is with us only in the winter, eats the eggs.

Last summer I had a nest of golden-winged woodpeckers breeding on my place at Hingham. Some of them dug into my barn and passed the winter. Only a part of my trees were protected by a belt of printers' ink and some of them were partially eaten, but this winter very few grubs have as yet shown themselves, and I give my friend *Colaptes auratus* the credit of all this. I know this—I gave the young ones a lot of the worms myself and they eat them as if they were used to them. The old birds were too shy to permit me to see by their good deeds.

I think the golden robin feeds its young with them so long as they last, but I am not sure that they eat the tent caterpillar. I nearly forgot the two cuckoos, yellow-bill and black-bill. They eat every form of caterpillar, canker worms included. I do not think the robin feeds any to its young, because it would never do; they are too small and its brood want a big lot. I have known the robin to feed its young for entire days, as fast as they could bring them, with the moth of the cut-worm. That is about as much as we could expect of any bird to do at one time. At the rate they went, they must have caught and given their young ones about five hundred of these moths in a day. Before that, I had supposed the robin did me more harm than good, but I had to give in. My indebtedness to that pair was worth all the cherries I could raise in many years. So the robin and I are fast friends."

From the facts already presented, it may be inferred how useful birds may become in the work of reducing the number of injurious insects. Undoubtedly we have suffered greatly by our wanton killing of the smaller birds. We are far behind European nations in caring for the insect-eating birds, and providing nests for them about our houses and gardens. The Swiss and French, have been the most far-sighted in this matter of the protection of the smaller insectivorous species. The English, Scandinavians and Germans foster them, while in our country, teeming as it is with hosts of ravaging insects, the smaller birds are hunted and persecuted, or if let alone, there is no effort made on any extended scale to invite them to our houses and gardens.

In this connection I may refer to the barbarous and thoughtless custom of our young men, in the autumn, organizing in companies and shooting small quadrupeds and birds. These hunting parties destroy large numbers of raccoons, foxes, skunks, mink, weasels and squirrels. It is well known that the skunk, if not an entirely inoffensive animal, is exceedingly useful. Its food consists mainly of insects, and those among the most injurious, such as the May beetle or dorbug. Mink and weasels eat insects, and squirrels as I am told, besides eating nuts, will in times of hunger eat the chrysalides of insects. It is known that all the smaller quadrupeds, even the fox, will eat insects when other food is wanting.

It is said that little harm results from shooting birds in autumn, as the breeding season is over, and the birds are migrating southward, but in the southern states they will prove as useful to agriculture there during their long winter residence, and it is a selfish policy that would injure the prosperity of farmers in one section of the country, merely to afford a day's barbarous pleasure to the inhabitants of another. Those birds which are shot in considerable numbers at such times, as partridges and quail, are insectivorous as well as vegetarians, and of late years the quail has been known to render essential service in consuming the Colorado potato beetle.

In fact this indiscriminate slaughter of small quadrupeds and birds tends to destroy the balance of nature. That there is a law of equilibrium in the distribution of the numbers of animals may be seen on a moment's examination of well known facts. The codfish is known to lay several hundreds of thousands of eggs, and yet such is the destruction of life, that few of the eggs are left untouched by other animals; and of the young that hatch, it may be safely said that only a pair of adult fish remain. Only two eggs of the original hundreds of thousands result in accomplishing the end for which so many were laid. So among the insects. The queen bee is known sometimes to lay during her whole life more than a million eggs; during the height of the breeding season, under the most favorable circumstances, laying from two thousand to three thousand eggs, and yet how slight is the increase in the numbers of the honey bee. It would be an interesting study to trace out the causes that cut short the lives of so many bees. Then look at the aphides or plant lice, with their anomalous virgin-reproduction, by which the young are produced like the buds on a tree. One virgin plant louse was found by Bonnet to bring forth on an average about one hundred young, and so on for ten generations: now add up the number of young produced by those of, say, ten broods, and we have the enormous number of 1,000,000,000,000, or a quintillion young—all descendants of one spinster plant louse. Says Professor Huxley in commenting on this fact, "I will assume that an aphis weighs $\frac{1}{1000}$ of a grain, which is under the mark. A quintillion will on this estimate weigh a quadrillion of grains. He is a very stout man who weighs 2,000,000 grains; consequently the tenth brood alone, if all the members survive the perils to which they are exposed, contains more substance than 500,000,000 stout men, to say the least, more than the whole population of China."

When we realize that so far from a quintillion, only a pair or two of plant lice survive, and at the end of the season die, after laying a few eggs, by which the species is represented in winter, we can form some idea of the struggle for existence among animals, and of the vicissitudes to which they are exposed. We can see how delicate is the balance of circumstances by which nature preserves the equilibrium, seeking, as it were, on the one hand to prevent the extinction of the species, and on the other its undue multiplication.

Now birds are an important agency in restraining the increase of species injurious to man. Yet this aid is blind and impartial. They devour useful as well as injurious insects. They sometimes eat our fruits, even if they overbalance the mischief by a strict adherence to insect diet out of the short fruit season. It follows that we must depend more upon an intimate knowledge of the habits of the birds themselves.

M. Perris in an admirable paper in the "*Mémoires de la Société Royale des Science de Liége*" (tome iii, 1873) entitled "*Les Oiseaux et les Insectes*" says:

> "Almost all birds, probably even the whole of them, eat insects. Even the birds of prey, when they are an hungered, accept this makeshift, as do also, according to M. Florent Prèvost, the wolf, the fox and the badger, when they have not been fortunate in the chase. There are some birds, such as the swallows, the martins, the goatsuckers, which live exclusively on insects; others, as the nightingale, the warblers and all the birds with small beaks, which habitually consume insects, and only change their habits at the latter end of autumn, then eating berries, figs, etc.; others such as the chaffinch, the goldfinch, the sparrow, which in rearing their young prefer insects to grain, and which for the rest of the time, prefer grain to insects. Still others, for example the magpie, are omnivorous: insects, worms, larvæ, grains, fruits, small birds, small chickens, all are welcome. Finally, not to prolong this

enumeration, for we should never finish if we mentioned all, the rapacious birds, such as the screech owl, the buzzard, the kite, more accustomed to live on flesh, are sometimes forced to content themselves with a morsel less succulent and less appropriate to their taste. From this very succinct and very incomplete résumé of the manner in which birds live, but which every one can extend and complete, it follows from the great number of birds that there is daily an immense destruction of insects. It is not by thousands only, but by hundreds of thousands, by millions, according to the area embraced, that we should count in fine weather and from one sunny day to another, the number of victims. The imagination shrinks at the idea of the total to which we should reach at the end of a year."

Mr. Perris then says, the main question is, How many of the insects thus eaten are injurious? We will quote our author's conclusions, though we think that in desiring to show that the protection and culture of birds are not the only way to prevent the attacks of injurious insects, as many of his countrymen think, he is a little disposed to underrate on his side their importance, which is felt in this country especially, in dealing with injurious caterpillars, such as the tent caterpillar, canker worm and the bud worm (*Penthina oculana*) of the apple and the pear, which would otherwise annihilate our apple and pear crop, as they almost threaten to do now. Remarks M. Perris :—

1. "Birds are only united in troops more or less considerable at the times of migration of autumn and spring, that is to say when most insects are infinitely less numerous than during the summer. The rest of the time, they live ordinarily in couples apart by themselves, quite rare in cultivated grounds, while the insects invade *en masse* the trees they wish to attack, the crops of which they are the enemies.

2. "Birds destroy insects enormously, but these insects are in great part neutral; some are eminently useful, and the species really injurious, compared to the whole, are scarcely at all reduced in numbers, as the birds, in consuming these little creatures, do not serve particularly our interests; they even injure us, many of them devouring our fruits as well as seeds either planted in the soil, or harvested, and especially in suppressing the carnivorous or parasitic kinds which render us great service.

3. "The insects of which we have the most to complain are either large enough to defy the birds, or (and these are the most formidable) too small to draw their attention; some of them taste too badly to excite their appetite; many are nocturnal and hide by day, with that instinct of self-preservation which is as much developed in them as in the larger animals; or, living inactive, they

do not reveal themselves to the eye of the bird, which perceives more easily and follows more willingly the insects which fly or move about. Some live under earth or in homes of their own; all are endowed with a fecundity which astonishes the imagination and which, in every case, is such that man, in spite of assiduous and persevering care, cannot even in a small farm, rid himself of them, nor often even free his house of them, not even a portion of it.

4. "The grubs and caterpillars, which are more especially the authors of the damages, live almost entirely concealed under the soil, under bark, deep in the road, in the stems of plants, in fruits, in inhabited places, under silken nets, and only pay the birds a very feeble tribute. Those which are developed in the open air are generally hairy, which repels birds; certain of them are nocturnal and disappear before day; others are protected by their excessive smallness."

Perris in another place enumerates other useful animals, and his remarks will apply in the main to this country:—

"There are among the mammalia, the moles, which without doubt do some mischief in covering our fields with mole hills . . . . . but they benefit us by destroying many insects and injurious grubs which live under the surface of the soil; besides the hedgehogs, the field mice, the great-headed field mouse (campagnol), the shrew mice, the bats, which are the more useful, in that they are nocturnal."

He also enumerates certain birds, and the larger number of the reptiles, adders, the blind worm, lizards, frogs, rennets, toad and turtle. The toads are of especial value as their only diet appears to be flies and grasshoppers and other insects. These animals are extremely sedentary. Wherever they find a supply of insects there they will remain for weeks at a time, as long as the supply lasts. On Penikese island, some of the students of the Anderson School of Natural History discovered that the stomachs of the numerous toads there were filled with young grasshoppers, and that they even hopped down to the shore and fed upon the beach-fleas which live under sea-weed between tide-marks. Toads are doubtless of use in devouring canker worms, as they abound under apple trees infested by them, and probably devour large quantities when the worms descend in June to the earth in order to undergo their transformation into the chrysalid state. It would be worth while to collect them in large numbers and place them in gardens and orchards, as once deposited there, they will remain.

Before I leave this subject of the agency of birds and other vertebrate animals in maintaining this equilibrium in the numbers of injurious and beneficial insects, I would urge the importance of a carefully conducted series of observations by some of our practical ornithologists and entomologists working in conjunction. From May until October one or several specimens of our most common insectivorous birds, as well as those occasionally so, should be daily collected, the time and nature of the day noted, and a list made of the species of insects found in their stomachs, the number of specimens, with other remarks. From the data thus collected we shall be able to form an intelligent opinion as to the vexed question, how far the birds devour indiscriminately injurious and beneficial insects; and I venture to predict that it will be found that the number of ichneumon and other beneficial kinds will form such a minimum as will be quite unimportant.

By far the most important agency in nature, and one almost incalculable in its effects, is the warfare of insects upon each other. We have seen how wonderfully fertile is the plant louse, though it may not lay an egg. Now the immense powers of multiplication of individuals in this and all other insects are held in check by carnivorous insects. One-half of the insects make war upon the other half. Insects attack one another in various ways, either by the stronger directly devouring the weaker; or as parasites they still more surely and effectually perform the work of destruction.

Among the external though less known enemies belonging to the order of beetles, which Perris enumerates from his extended observations on their habits, are a large number which live under the bark of trees. I quote his accounts of them, premising that we have similar insects with like habits in this country; and though the list of scientific names seems formidable, yet there are no common names for them. I use nearly his own words, with occasional interpolations of English names.

"When one of the Scolytids injurious to pines (the *Bostrichus stenographus*) lays its eggs under the bark, the *Platysoma oblongum* introduces itself by the hole which has given entrance to the first named insect, it lays its eggs in the gallery of the Bostrichus, and from those eggs are born the carnivorous larvæ which devour those of the wood-eating beetles. Other beetles conduct themselves in the same manner in warring against other Scolyti. The larvæ or grubs of *Plegaderus discisus* destroy the young of *Crypturgus pusillus*; another wood-eating beetle, the *Aulonium sulcatum*, is the deadly enemy of *Scolytus destructor*, so formidable a foe to shade trees; *Aulonium bicolor* attacks *Bostrichus laricis; Colydium* *bicolor* preys upon the Bostrichus of the larch; *Colydium elongatum* on *Platypus cylindrus*, *Rhizophagus depressus* on *Blastophagus piniperda* and *B. minor*, *Læmophlœus hyperbori* on *Hyperborus ficus*, *Hypophlœus pini* on *Bostrichus stenographus*, and finally *Hypophlœus linearis* on *Bostrichus bidens*. Who will not be struck by these antagonisms? Who will not admire this infallibility of instinct which causes these insects to discover the tree attacked, and perceive, among the species which the tree conceals, the victim which has been assigned to them?"

"Other beetles exhibit the same sagacity. The larvæ of several Elaterids (wire worms) and those of *Clerus mutillarius* and *formicarius* make war on those of some longicorn beetles of the oak, the elm, alder bush and the pine. The *Opilus mollis* and *domesticus* are the enemies of the borers which mine our floors and ceilings; the *Cylidrus albofasciatus* and the *Tillus unifasciatus* prey on *Synoxylon sexdentatum* and on *Xylopertha sinuata* which seek the diseased branches of the vine, and those of several trees; the *Tarsostenus univittatus* attacks the *Lyctus canaliculatus*, injuring our timber works; while the *Trogosita Mauritanica* destroys the grain moth."

We would also add among other efficient laborers in the cause of agriculture the lady birds, lace-winged flies, Syrphus flies and numerous wasps. But the true parasites, the ichneumon and Tachina flies, those which live within the bodies of vegetable-eating insects, these are the aids which beyond all other influences keep in check the noxious kinds. It may be said that each sort of caterpillar has its peculiar ichneumon parasite, and some are known to have several. Here we have an engine of destruction which man can in some measure direct. We have seen that birds eat friend and foe indiscriminately. The great practical question in applied entomology is how can man breed and disseminate these insects, and use them as most potent instruments of warfare against insect depredators. This question has been satisfactorily settled for the first time by Dr. W. LeBaron, the State Entomologist of Illinois. So important and suggestive are his remarks that I quote the whole chapter on "The transportation of useful parasitic Insects" from his able report for 1873, as it deserves the widest dissemination among thinking agriculturists.

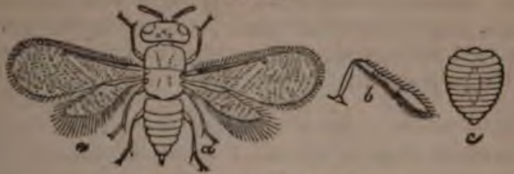
"The idea of rearing the useful parasitic insects, and of transporting them, when necessary, from one part of the country to another, has often presented itself to practical entomologists, and was a favorite topic of speculation of my predecessor in office, B. D. Walsh. But the very small size of most of these insects, many of them, indeed, being so minute that they cannot easily be seen without the aid of a lens, and the constant difficulty of manipulating them have always given a somewhat chimerical aspect to the suggestion, and have caused it to be regarded as more ingenious than practicable.

"In the course of our investigation of the oyster-shell bark louse of the apple tree, in the year 1870, we discovered a minute chalcis fly, which we designated as the chalcideous parasite of the oyster-shell bark louse, *Chalcis* (Aphelinus) *mytilaspidis*, which was found to be extensively instrumental in extirpating that deadly enemy of the apple tree, by boring into the scale and depositing her own eggs in the body, or in the midst of the eggs of the bark louse. The parasitic larvæ which hatched from this egg lived at the expense of the bark louse and its eggs, and thus caused their destruction. It was found that in several of the counties of this state where the examinations were made, that more than half of the bark lice had been destroyed by this parasite, its operations being known, partly by the presence of the little grubs beneath the scales, and partly by the minute round holes in the scales, through which the chalcis flies had escaped. It was also found, by examining the scale, late in the fall, that one brood of the chalcides hibernated in the larva state beneath the scales. The idea, therefore, readily occurred that this was a very favorable opportunity for testing the practicability of transporting these friendly parasites to those parts of the country in which their presence cannot now be detected. We had previously received several packages of apple twigs from different localities in the northern part of Illinois and the southern part of Wisconsin, heavily infested with the scales of the bark louse, but without any traces of the parasitic chalcides, and this section of country seemed therefore to furnish a favorable field in which to try the experiment of colonization.

"Captain Edward H. Beebe, of Galena, who had been passing the winter in Geneva, and who had taken a lively interest in this investigation, undertook to conduct this interesting experiment. Early in the spring of 1871, on his return to Galena, he took a package of twigs, which we had procured from trees known to have been inhabited by the chalcides, and under some of the scales upon which it was therefore probable that the larvæ were hibernating. These he tied upon trees in three different orchards, in the town of Galena, which were known to be badly infested by bark lice.

"When we consider the minute size of these insects, the fully matured fly (Fig. 72) being only one twenty-fifth of an inch in length, and that the hole in the scale of the bark louse which reveals the operation of the chalcis is so minute that it can only be seen by the aid of a magnifying glass; and we further take into account that probably less than a dozen of these larvæ were transported to the new locality, and that the small number of parasitic flies proceeding from these were let loose in three orchards containing many hundreds of apple trees, we may form some idea of the difficulties of this experiment, and of the uncertainty which would be likely to attend any observations made for the purpose of determining the presence of the chalcides. Even if the experiment should prove ultimately successful, it would be very doubtful whether the chalcis marks would be sufficiently numerous to be detected at the close of the first year, but after this they would be likely to multiply in a rapidly increasing ratio.

Fig. 72.



Aphelinus of the Apple Scale Insect.

"About the last of May, 1872, that is, after the intervention of one year from the time of commencing this experiment, Capt. Beebe examined some of the trees to which the chalcis twigs had been attached, and after a careful search thought that he had discovered a few traces of the operations of the chalcides, and sent half a dozen of the twigs bearing these marks to me for inspection. . . . . . On the 13th of July, I visited Galena and, in company with Capt. Beebe, submitted one of the trees, to which the greatest number of the twigs had been attached, to a thorough examination.

"The result, if not actually conclusive, was at least extremely encouraging. We detected a considerable number of holes in the scales, which appeared to be identical, in every respect, with those made by the chalcis in question, and in one instance we discovered three of these holes upon the same twig, within a space of four inches.

"In conducting an experiment of so delicate a nature I am well aware that the greatest caution must be exercised to avoid jumping to hasty conclusions, and that the observations of a number of succeeding years will be necessary before we can arrive at a definite conclusion that the experiment has been followed by a practical as well as scientific success.

"At the close of the author's article upon the oyster-shell bark louse, in his first annual report, after speaking of the absence of any signs of the chalcides, in the northernmost part of the state, and of the possible practicability of transporting them thither, we concluded with the following remark: 'The absence of the chalcis of the bark louse, in this locality, will furnish an excellent opportunity for testing the practicability of transporting it thither from those places where it is known to exist. If, after taking the preliminary steps, as described in a former part of this article, we should find, after the lapse of the necessary time, upon the trees experimented with, the characteristic holes in the scales which mark the exit of the chalcis, we should know that the friendly parasite had entered upon its work. If such an experiment could be conducted to a successful issue, it would furnish one of the most admirable instances on record, of the triumph of science, in its application to economic entomology.'"

In like manner the Hessian fly and wheat midge could, we believe, be kept within legitimate bounds, by the transportation from Europe of the parasites that in England and France are known to reduce their numbers materially. It would be an easy task to cause several bags of stubble containing the cocoons of these parasites to be sent over to this country, and reared here. So also the dreaded cabbage butterfly, our last European importation, can in new districts be kept under by transporting the Pteromalus or chalcis parasite, which in Essex county, Mass., is quite abundant. This rearing of ichneumon parasites can be carried on by intelligent gardeners and farmers in conjunction with an entomologist, and we look upon the future of ichneumon culture as one of the departments of a scientific, intelligent agriculture. Something should be done in the matter by the national department of agriculture, and instead of disseminating frightfully injurious insects in the seeds distributed from Washington, as is sometimes done through carelessness, it would be less harmful to scatter broadcast papers of ichneumon seed.

HABITS AND CHARACTERISTICS OF SWAINSON'S BUZZARD.

BY DR. ELLIOTT COUES, U. S. A.

THIS large hawk is very abundant in northern Dakota, where it came under my observation almost daily during the summer of 1873. Excepting an occasional rough-leg or red-tail, it was the only buteonine species observed, and the only hawks more common were the ubiquitous marsh harriers and sparrow-hawks.

The species is thoroughly distinct from its nearest ally, *B. borealis;* it never gains the red tail, so characteristic of the latter, and differs in other points of coloration in its several stages of plumage, as noted beyond. Although its linear dimensions intergrade with those of the red-tail, it is not so heavy nor so large a bird, and its shape differs in some points. A tangible and very convenient distinction, to which my attention was first called by Mr. Ridgway, and which I have verified in numerous instances, is found in the emargination of the primaries. As stated in my late work (Key N. A. Birds, p. 217), Swainson's buzzard has only *three* emarginate primaries, while the red-tail has *four;* the fourth quill of the former, like the fifth of the latter, is variously sinuate-tapering, but never shows the decided nick or emargination of the inner web.

The following measurements, taken in the flesh, illustrate the sexual difference and other variations in size: Largest adult ♀ 22 inches long, 54 in extent, the wing 16; other females respectively 21·50×51·75×16·25. . . . 21·00×53·00×15·75. . . . 20·50×51·00×15·25. . . . 19·00×49·00×13·50; but this last one was an ungrown young. Adult ♂ 19·00 to 20·00 long, by about 49·00 in spread of wing, the latter 15·00 and a little more. In both sexes, and at all ages, the eye is brown, but of varying shade—I have seen no approach to a yellow iris. In the old birds the feet, together with the cere, gape, and base of under mandible are rich chrome yellow; the rest of the bill, and the claws, being bluish black. In the young of the year these yellow parts are much duller—grayish-yellow, or yellowish clay-color. Most of the old birds I have skinned had the integument of the lower belly largely bare, yellowish in color, hardened and thickened with warty excrescences; this disease seemed the rule rather than the exception. Unfledged nestlings are covered with white fluffy down; the first feathers to appear on the under parts show the characteristic color and markings of the formerly supposed species, "*B. Bairdii.*" (The various plumages are given beyond.) A moult occurs in August and September; it is protracted, the feathers being very gradually renewed, almost one by one; the fresh heavily colored feathers contrasting strongly with the ragged and faded ones worn during the summer. The young have no moult at this season, carrying the plumage in which they leave the nest into the winter. I have no observations upon a spring moult which probably occurs to both old and young. I took no specimens in the melanistic state of plumage in which the bird has been described as another supposed species—*B. insignatus;* and only saw one in which the entire under parts looked as dark, when the bird was sailing over me, as the pectoral band of the adults is. This dark plumage appears to be an individual peculiarity, not a normal stage of regular occurrence.

Swainson's buzzard may be seen anywhere in the region mentioned—even far out on the prairie, miles away from timber, circling over head, or perched on the bare ground. In alighting, it generally takes advantage of some little knoll commanding a view around, though it often has no more prominent place than the cart-load of dirt from a badger's hole, from which to cast about for some imprudent gopher* espied too far from home, or still more ignoble game. But the bird prefers timber, and, especially as its nesting is confined to trees, it is most frequently observed in the vicinity of the few wooded streams that diversify the boundless prairie. In northern Dakota such streams cut their tortuous way pretty deeply into the ground, and the sharp edges of the banks, rising steep on one side and on the other stretching away on a continuous level, are favorite resting spots, where sometimes a line of several birds may be observed strung along a distance of a few yards. The Souris or Mouse River, a stream of this description, is a favorite resort, where I found the birds more numerous than anywhere else. Much of the river bottom is well wooded with elm, oak and other large trees; and the number of nests found in this timber—sometimes several in sight of each other—would be considered surprising by one not recollecting that conveniences for breeding are in this country practically limited to such narrow tracts.

The nests are built at varying heights, from the intricacies of heavy shrubbery where a man may reach them from the ground, to the tops of the tallest trees. They are generally, however, placed thirty or forty feet high, in some stout crotch or on a horizontal fork. They are bulky and ragged looking structures, from the size of sticks used for the base and outside; the interior is composed of smaller twigs more compactly arranged. The shape varies with the requirements of the location, being more or less conical in an upright crotch, flatter on a fork. The interior hollowing is slight. An average external diameter may be given as two feet, and depth half as much. I was too late for eggs in the locality above mentioned; the only nest I found with anything in it contained two half-fledged young. This was on the 15th of August—so late as to induce the belief that perhaps two broods may be reared in a season, especially as before this date I had observed many full grown yearlings on the wing. This nest built about forty feet high, in an oak tree, was very untidy, matted inside with excrement and the scurfy exfoliation from the growing feathers of the youngsters, and encumbered with portions of several gophers. The nestlings were too young to make any resistance beyond a menacing hiss and a very mixed flapping when they were unceremoniously pitched out. The mother was shot near the nest with a pistol-ball, but her partner kept prudently out of the way. This bird had not reached her mature plumage. The young had been well cared for; their crops were full of gopher-meat at the time, and they were very fat.

---

* "*Gopher*": Frontier vernacular name for all the ground-squirrels (*Spermophili*) indiscriminately. *S. tridecem-lineatus* is the commonest kind here. The pouched rats are known as "pocket-gophers."

In July, I had a live young one in captivity, at about the age of these two; and early in August, I possessed a completely feathered and full grown bird of the year, probably hatched in May. This shows that either two broods are reared, or that the laying season runs through most of the summer. This grown young one made rather an acceptable capture for some days, as he was trim and shapely, with a fine eye and general military bearing, as well as an excellent appetite. But then he was bad-tempered, took the most civil advances unkindly, and would not even fraternize with a pair of very well disposed and sensible owls that were picketed with him. At last, when he so totally failed to appreciate his position as to use his claws with painful effect, he was summarily executed. Both this and the younger one before him had a peculiarly plaintive whistle to signify hunger or a sense of loneliness, a note that was almost musical in intonation. This was the only cry I heard from them; the old birds have the harsh loud scream, much alike in all our large hawks.

The quarry of Swainson's buzzard is of a very humble nature. I never saw one stoop upon a wild-fowl or grouse, and though they probably strike rabbits, like the red-tails, their prey is ordinarily nothing larger than gophers. Though really strong and sufficiently fierce birds, they lack the "snap" of the falcons and asturs; and I scarcely think they are smart enough to catch birds very often. I saw one make the attempt on a lark-bunting. The hawk poised in the air, at a height of about twenty yards, for fully a minute, fell heavily with an awkward thrust of the talons—and missed; the little bird slipped off badly scared no doubt, but unhurt, while the enemy flapped away sulkily, very likely to prowl around a gopher-hole for his dinner, or take potluck at grasshoppers. They procure gophers, mice and other small quadrupeds both by waiting patiently at the mouth of the holes, ready to claw out the unlucky animals the moment they show their noses, and by sailing low over the ground to pick up such as they may find away from home. But I question whether, after all, insects do not furnish their principal subsistence. Those that I shot after midsummer all had their craws stuffed with grasshoppers. These insects, which appear sometimes in almost inconceivable numbers, seem to be the natural source of supply for a variety of animals. Wolves, foxes, badgers, and even the rodents, like gophers, supposed vegetarians, come down to them. Sandhill cranes stalk over the prairie to spear them by thousands. Wild-fowl waddle out of the reedy pools to scoop them up; we may kill scores of sharp-tailed grouse, in September, to find in every one of them a mass of grasshoppers, only leavened with a few grubs, beetles leaves, berries and succulent tops of plants. It is amusing to see a hawk catching grasshoppers; skipping about "like a hen on a hot gridiron," in an awkward way, and looking as if he were rather ashamed of being seen in such a low performance. Food being so abundant and easily procured, the birds become extremely fat early in the autumn, and lazy withal. Unaccustomed to the presence of man in these regions, they may be approached with little difficulty as they perch on the trees, and often fly unwittingly within short range. When brought down winged they show no lack of spirit, and must be prudently dealt with, as their talons are very effective weapons of defence.

Changes of plumage with age affect more particularly the under parts, the back, wings and tail being more nearly alike at all times.

Young-of-the-year (both sexes). Entire upper parts dark brown, everywhere varied with tawny edgings of the individual feathers. The younger the bird, the more marked this variegation; it corresponds in tints closely with the color of the under parts, being palest in very young examples.

Under parts, including lining of wings, nearly uniform fawn-color (pale dull yellowish-brown), thickly and sharply marked with blackish-brown. These large dark spots, for the most part circular or guttiform, crowd across the fore breast, scatter on the middle belly, enlarge to cross-bars on the flanks, become broad arrowheads on the lower belly and tibiæ, and are wanting on the throat, which is only marked with a sharp narrow blackish pencilling along the median line. Quills brownish-black, the outer webs with an ashy shade, the inner webs toward the base grayish, paler and marbled with white, and also showing obscure dark cross-bars; their shafts black on top, nearly white underneath. Tail feathers like the quills, but more decidedly shaded with ashy or slate gray, and tipped with whitish: their numerous dark cross-bars show more plainly than those of the quills, but are not so evident as they are in the old birds.

Adults (either sex). Upper parts dark brown, very variable in shade according to season or wear of the feathers, varied with paler brown, grayish or even reddish brown edgings of the feathers, but without the clear fawn color of the young: the feathers of the crown showing whitish when disturbed, and usually sharp dark shaft lines; the upper tail coverts chestnut and white with blackish bars. Quills and tail feathers as before, but the inner webs of the former showing more decided dark cross-bars upon a lighter marbled-whitish ground; and the latter having broader and sharper dark wavy bars. These large quills, particularly those of the tail, vary much in shade according to wear, the new feathers being strongly slate-colored, the old ones plain dark brown. The tail, however, never shows any trace of the rich chestnut that obtains in the adult *B. borealis*. *Male:* Under parts showing a broad pectoral area of bright chestnut, usually with a glaucous cast and displaying sharp black shaft lines; this area contrasting sharply with the pure white throat. Other under parts white, more or less tinged and varied, according to age, with light chestnut. In the oldest males, this chestnut is diminished to traces, chiefly in flank-bars and arrowheads, and the white throat is immaculate; in less mature examples, throat shows blackish pencilling, and the rest of the under parts are so much marked with chestnut, chiefly in cross-bars, that this color predominates over the white, and appears in direct continuation of the pectoral area itself. Some feathers of this area are commonly dark brown. *Female:* Much darker underneath than the male; throat pure white, but other under parts probably never whitening decidedly. Pectoral from rich dark chestnut or mahogany color, mixed with still darker feathers, to brownish-black, and other under parts heavily marked with chestnut, chiefly in cross-bars alternating with whitish, but on the flanks, and sometimes across the belly, these markings are quite blackish. The general tone of the under parts may be quite as dark as the pectoral area of the male; but it lacks uniformity, and the increased depth of color of the pectoral area in this case suffices to preserve the strong contrast already mentioned.

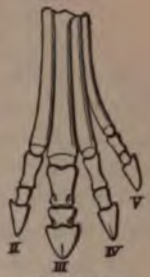
FOSSIL HORSES IN AMERICA.

BY PROFESSOR O. C. MARSH.

It is a well known fact that the Spanish discoverers of America found no horses on this continent, and that the modern horse (*Equus caballus* Linn.) was subsequently introduced from the old world. It is, however, not so generally known that these animals had formerly been abundant here, and that long before, in Tertiary time, near relatives of the horse, and probably his ancestors, existed in the far west in countless numbers, and in a marvellous variety of forms. The remains of equine mammals, now known from the Tertiary and Quaternary deposits of this country, already represent more than double the number of genera and species hitherto found in the strata of the eastern hemisphere, and hence afford most important aid in tracing out the genealogy of the horses still existing.

The animals of this group which lived in this country during the three divisions of the Tertiary period were especially numerous in the Rocky Mountain regions, and their remains are well preserved in the old lake basins which then covered so much of that country. The most ancient of these lakes—which extended over a considerable part of the present territories of Wyoming and Utah—remained so long in Eocene times that the mud and sand, slowly deposited in it, accumulated to more than a mile in vertical thickness. In these deposits, vast numbers of tropical animals were entombed, and here the oldest equine remains occur, four species of which have been described. These belong to the genus *Orohippus* Marsh, and are all of diminutive size, hardly larger than a fox. The skeleton of these animals resembled that of the horse in many respects, much more indeed than any other existing species, but instead of the single toe on each foot, so characteristic of all modern equines, the various species of *Orohippus* had four toes before and three behind, all of which reached the ground. The skull, too, was proportionately shorter, and the orbit was not enclosed behind by a bridge of bone. There were forty-four teeth in all, and the premolars were smaller than the molars. The crowns of these teeth were very short. The canine teeth were developed in both sexes, and the incisors did not have the "mark" which indicates the age of the modern horse. The radius and ulna were separate, and the latter was entire throughout its whole length. The tibia and fibula were distinct. In the fore foot, all the digits except the pollex, or first, were well developed, as shown in the accompanying figure (73) of the left fore foot of *Orohippus agilis* Marsh. The third digit is the largest, and its close resemblance to that of the horse is clearly marked. The terminal phalanx, or coffin bone, has a shallow median groove in front, as in many species of this group in the later Tertiary. The fourth digit exceeds the second in size, and the fifth is much the shortest of all. Its metacarpal bone is considerably curved outward. In the hind foot of this genus, there are but three digits. The fourth metatarsal is much larger than the second.

Fig. 73.



Orohippus agilis.

The only species of *Orohippus* at present known are from the Eocene of Wyoming and Utah, and are as follows:—*Orohippus gracilis* Marsh, *O. pumilus* Marsh, *O. agilis* Marsh, and *O. major* Marsh.*

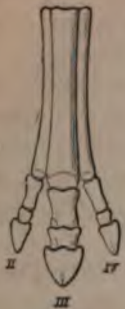
In the middle Tertiary, or Miocene, there were two other lakes on either side of the great Eocene basin. The largest of these was east of the Rocky Mountains, extending over portions of what are now Dakota, Nebraska and Colorado. The clays deposited in this lake form the "*Mauvaises terres*," or "Bad lands," of that region, and are well known for their fossil treasures. The other Miocene lake was west of the Blue mountains, where eastern Oregon now is, but its extent is unknown, as this whole region has since been covered with a vast sheet of basalt, a thousand or more feet in thickness, and the original lake sediments are only to be seen where this lava has been washed away. In both of these ancient lake basins, many remains of animals allied to the horse are found, showing that during the Miocene this group of mammals were well represented.

In the western, or Oregon basin, the genus *Miohippus* Marsh first makes its appearance. It resembles *Orohippus* of the Eocene in its general characters, especially in the shape of the skull, number and form of teeth, and separate ulna; but it had only three toes in the fore foot, as well as behind, and the fibula was coössified with the tibia at its lower end. In this genus, all the toes reached the ground, as shown in the accompanying figure of the left fore foot of *Miohippus annectens* Marsh, the type species (Fig. 74). In the same deposits, the genus *Anchitherium* Meyer occurs, represented by a single species, *A. anceps* Marsh. This genus is closely allied to *Miohippus*, but differs in having a deep depression in the skull in front of the orbit. The radius and ulna are united, and the outer toes are reduced in size. In the eastern basin, *Anchitherium Bairdi* Leidy is abundant, and with it is found a smaller species, *A. celer* Marsh. The animals of these two genera are all larger than the species of *Orohippus* from the Eocene, some of them exceeding a sheep in size. The Miocene species known with certainty are as follows:—*Miohippus annectens* Marsh, *Miohippus Condoni* (*Anchitherium Condoni* Leidy) and *Anchitherium anceps* Marsh, from Oregon; and *A. Bairdi*, Leidy, and *A. celer* Marsh, from the eastern basin.

---

* American Journal of Science, Vol. vii, p. 247, March, 1874.

Fig. 74.



Miohippus annectens.

During the Pliocene, or later Tertiary, a great development of the horse family took place, and vast numbers of these animals left their remains in the lake deposits of that epoch. The largest of these lakes had the Rocky Mountains for its western border, and extended from Dakota to Texas, its northern part covering the bed of the older Miocene basin. Another Pliocene lake, of unknown limits, extended over the older Tertiary strata of eastern Oregon, and evidence of still others may be seen in Idaho, Nevada and California. In all of these basins, equine remains of various kinds have been found, but the most important localities are the region of the Niobrara river east of the mountains, and the valley of the John Day river in Oregon.

The equine genera of the Pliocene which appear to be most nearly related to their predecessors from older strata are, *Anchippus* Leidy, *Hipparion* Christol, and *Protohippus* Leidy, all three-toed forms, but with the outer digits reduced to much the same proportions as the posterior hooflets of the modern deer and ox. The genus *Pliohippus* Marsh, from the same deposits, had feet like those of the recent horse. Other genera, less known, which have been proposed, are *Parahippus*, *Merychippus*, and *Hypohippus* of Leidy, to whose researches we are so largely indebted for our present knowledge of this group. Of these Pliocene genera, more than twenty species have been described from American strata, all apparently larger than their Miocene relatives, but all smaller than the present horse, and many of them approaching the ass in size. Among the more characteristic of these species may be mentioned, *Anchippus Texanus* Leidy, from Texas; *A. brevidens* Marsh, from Oregon; *Hipparion occidentale* Leidy, and *H. speciosum* Leidy, from Nebraska; *Protohippus perditus* Leidy, from the Niobrara; *P. parvulus* Marsh, from Nebraska, the smallest Pliocene species; *Parahippus cognatus* Leidy, and *Pliohippus pernix* Marsh, from the Niobrara.

In the upper Pliocene, or more probably in the transition beds above, there first appears a true *Equus*, and in the Quaternary deposits, remains of this genus are not uncommon. Five or six species are known from the United States, and several others from Central and South America. The latest extinct species appears to have been *Equus fraternus* Leidy, which cannot be distinguished anatomically from the existing horse. These later extinct horses are all larger than the Pliocene Equines, and some of them even exceeded in size the living species.

The large number of equine mammals now known from the Tertiary deposits of this country, and their regular distribution through the subdivisions of this formation, afford a good opportunity to ascertain the probable lineal descent of the modern horse. The American representative of the latter is the extinct *Equus fraternus* Leidy, a species almost, if not entirely, identical with the old world *Equus caballus* Linn., to which our recent horse belongs. Huxley has traced successfully the later genealogy of the horse through European extinct forms,* but the line in America was probably a more direct one, and the record is more complete. Taking, then, as the extremes of a series, *Orohippus agilis* Marsh, from the Eocene, and *Equus fraternus* Leidy, from the Quaternary, intermediate forms may be intercalated with considerable certainty from the thirty or more well marked species that lived in the intervening periods. The natural line of descent would seem to be through the following genera: — *Orohippus*, of the Eocene; *Miohippus* and *Anchitherium*, of the Miocene; *Anchippus*,

---

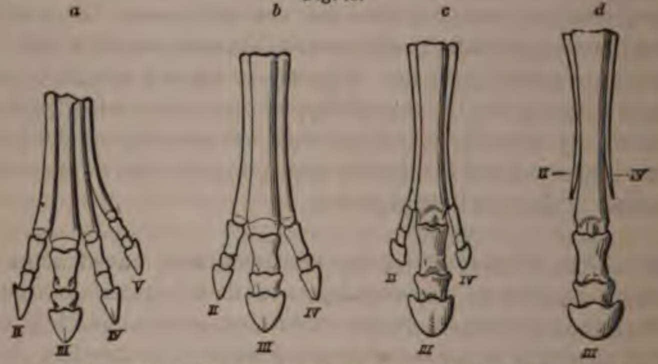
* Anniversary Address, Geological Society of London, 1870.

Hipparion, *Protohippus* and *Pliohippus*, of the Pliocene; and *Equus*, Quaternary and recent.

The most marked changes undergone by the successive equine genera are as follows: 1st, increase in size; 2d, increase in speed, through concentration of limb bones; 3d, elongation of head and neck, and modifications of skull. The increase in size is remarkable. The Eocene *Orohippus* was about the size of a fox. *Miohippus* and *Anchitherium*, from the Miocene, were about as large as a sheep. *Hipparion* and *Pliohippus*, of the Pliocene, equalled the ass in height: while the size of the Quaternary *Equus* was fully up to that of the modern horse.

The increase of speed was equally marked, and was a direct result of the gradual modification of the limbs. The latter were slowly concentrated, by the reduction of their lateral elements and enlargement of the axial one, until the force exerted by each limb came to act directly through its axis, in the line of motion. This concentration is well seen, *e. g.*, in the fore limb. There was, 1st, a change in the scapula and humerus, especially in the latter, which facilitated motion in one line only; 2d, an expansion of the radius, and reduction of the ulna, until the former alone remained entire, and effective; 3d, a shortening of all the carpal bones, and enlargement of the median ones, ensuring a firmer wrist; 4th, an increase in size of the third digit, at the expense of those on each side, until the former alone supported the limb. The latter change is clearly shown in the above diagram (Fig. 75), which represents the fore feet of four typical genera in

Fig. 75.



a, Orohippus (Eocene); *b*, Miohippus (Miocene); *c*, Hipparion (Pliocene); *d*, Equus (Quaternary).

the equine series, taken in succession from each of the geological periods in which this group of mammals is known to have lived.

The ancient *Orohippus* had all four digits of the fore feet well developed. In *Miohippus*, of the next period, the fifth toe has disappeared, or is only represented by a rudiment, and the limb is supported by the second, third and fourth, the middle one being the largest. *Hipparion*, of the later Tertiary, still has three digits, but the third is much stouter, and the outer ones have ceased to be of use, as they do not touch the ground. In *Equus*, the last of the series, the lateral hoofs are gone, and the digits themselves are represented only by the rudimentary splint bones.* The middle, or third digit, supports the limb, and its size has increased accordingly. The corresponding changes in the posterior limb of these genera are very similar, but not so striking, as the oldest type (*Orohippus*) had but three toes behind. An earlier ancestor of the group, perhaps in the lowest Eocene, probably had four toes on this foot, and five in front. Such a predecessor is as clearly indicated by the feet of *Orohippus*, as the latter is by its Miocene relative. A still older ancestor, possibly in the Cretaceous, doubtless had five toes in each foot, the typical number in mammals. This reduction in the number of toes may, perhaps, have been due to elevation of the region inhabited, which gradually led the animals to live on higher ground, instead of the soft lowlands where a polydactyl foot would be an advantage.

The gradual elongation of the head and neck, which took place in the successive genera of this group during the Tertiary period, was a less fundamental change than that which resulted in the reduction of the limbs. The process may be said to have already began in *Orohippus*, if we compare that form with other most nearly allied mammals. The diastema, or "place for the bit," was well developed in both jaws even then, but increased materially in succeeding genera. The number of the teeth remained the same until the Pliocene, when the front lower premolar was lost, and subsequently the corresponding upper tooth ceased to be functionally developed. The next upper premolar, which in *Orohippus* was the smallest of the six posterior teeth, rapidly increased in size, and soon became, as in the horse, the largest of the series. The grinding teeth at first had very short crowns, without cement, and were inserted by distinct roots. In Pliocene species, the molars became longer, and were more or less coated with cement. The modern horse has extremely long grinders, without true roots, and covered with a thick external layer of cement. The canine teeth were very large in *Orohippus*, and in this genus, as well as those from the Middle Tertiary, appear to have been well developed in both sexes. In later forms, these teeth declined in size, especially as the changes in the limbs afforded other facilities for defence, or escape from danger. The incisors in the early forms were small, and without the characteristic "mark" of the modern horse. In the genera from the American Eocene and Miocene, the orbit was not enclosed behind by an entire bridge of bone, and this first makes its appearance in this country in Pliocene forms. The depression in front of the orbit, so characteristic of *Anchitherium* and some of the Pliocene genera, is, strange to say, not seen in *Orohippus*, or the later *Miohippus*, and is wanting, likewise, in existing horses. It is an interesting fact that the peculiarly equine features acquired by *Orohippus* are retained persistently throughout the entire series of succeeding forms. Such, *e. g.*, is the form of the anterior part of the lower jaw, and also the characteristic astragalus, with its narrow, oblique, superior ridges, and its small articular facet for the cuboid.

---

* The modern horse occasionally has one of the ancestral hooflets developed, usually on the fore foot.

Such is, in brief, a general outline of the more marked changes that seem to have produced in America the highly specialized modern *Equus* from his diminutive, four-toed predecessor, the Eocene *Orohippus*. The line of descent appears to have been direct, and the remains now known supply every important intermediate form. It is, of course, impossible to say with certainty through which of the three-toed genera of the Pliocene that lived together, the succession came. It is not impossible that the later species, which appear generically identical, are the descendants of more distinct Pliocene types, as the persistent tendency in all the earlier forms was in the same direction. Considering the remarkable development of the group through the entire Tertiary period, and its existence even later, it seems very strange that none of the species should have survived, and that we are indebted for our present horse to the old world.

NOTES FROM THE JOURNAL OF A BOTANIST IN EUROPE.

BY W. S. FARLOW, M.D.

PART III. GENEVA AND THE ALPS.

After a month of wandering through Switzerland and northern Italy, I have, at length, settled in this charming city for the purpose of more systematic botanical study than one is likely to undertake in such resorts as Grindelwald and Zermatt. I arrived in Switzerland from Munich about the middle of July, and reached Grindelwald on the 20th, when the alpine vegetation was in full bloom, and I think I never saw such a display of wild flowers as was then to be found in almost all the high pastures, or Alps proper, and, still higher up, on exposed rocks just below the snow line. For the European botanist, who is only in search of rarities, Zermatt is much richer than Grindelwald. In general, Dauphiny is more favorable for the botanist than Switzerland itself, but to an American, who must, at least, see Switzerland and who wishes to get a good general idea of the alpine flora at the same time, no place seems to me better adapted than Grindelwald. The valley is easily and quickly reached and, only a few steps from the village, is the moraine of the lower glacier which, by a constant recession (according to the guides) for twenty years, has left exposed a mass of rocks on which, but more particularly along their border, may be found numerous alpine and sub-alpine plants. Amongst the most beautiful and common, are *Linaria alpina* DC. and *Epilobium Fleischeri* Hochst. which attract the eye of non-botanical travellers, and even of the guides themselves. To the left of the moraine (looking up) and along the path leading to the *mer de glace* one can without fatigue collect alpine plants to his heart's content, including even the famous Edelweiss, *Leontopodium alpinum* Cass., unless he arrives a little late in the season, in which case, every trace of it will have disappeared under the devastations of guides and tourists. For my part, I can't see the least beauty in the flower, and it was a great annoyance to have a handful thrust into my face every few minutes by some enterprising, but not over-polite, Swiss boy. It does very well, however, for the guides to wear a sprig in their hats, it gives them such a decided alpine look and, then, it is so romantic. Every one has heard about the chamois hunters who imperil their lives in gathering the Edelweiss growing about half-way up steep precipices, nobody knows how many thousand feet high, all for the sake of some beauteous maiden. At present, maidens of the above class have probably retired to the remotest valleys; at any rate, they are not met with in Grindelwald. But Edelweiss may be had without great risk of life or limb; for while crossing the Simplon I had only to step out of the diligence to pick specimens of it growing on some rocks near the road. But, to return to our path to the *mer de glace* — along the lower portion a most beautiful effect is produced by the quantities of *Phalangium ramosum* Lam. and *Astrantia major* L., growing together, the latter proving that even an umbellifer can be beautiful. Above, on the mountain, *Aconitum Napellus* and *A. lycoctonum*, with numerous Caryophyllaceæ, attract the attention of the traveller.

No one who is so fortunate as to be in Grindelwald in July, or the beginning of August, should fail to ascend the Faulhorn. After emerging from the forest, uninteresting, except from a few *Campanulæ*, to all but lichenologists, one finds in abundance the beautiful alpine rose, *Rhododendron ferrugineum* L., which the ladies are so fond of fastening in bunches to the ends of their alpenstocks; and, growing with it in abundance, but flowering a little later, the odd *Gentiana punctata* L. After passing the châlet, the really alpine flora is first seen in a meadow blue with *Gentiana Bavarica* and *G. verna* mixed with Androsace, while the most beautiful *G. acaulis* occurs farther on. Every step discloses new beauties, the fragrant *Nigritella angustifolia*, *Violæ*, *Primulæ*, *Semperviva*, *Saxifragæ* and composites without end, till the climax is reached at a little knoll not far from a small black looking lake, just under the snow fields, which is covered with *Soldanella minima* Hoppe. The nodding of the beautiful little purple-blue corollas, the distant tinkling of hundreds of bells from a large herd in the alp below, the bare black rocks and snow ahead, and behind the magnificent mass of the Wetterhorn, from which one hears constant avalanches, all form a picture which no one is likely to forget.

The proper time for seeing the alpine flowers is from the middle of July till the middle of August, better however in July. Those who arrive late in August, as do most of the Americans, will search in vain, even in the richest localities, for a glimpse at the wonderful profusion and brilliancy of the mountain flora. Single specimens of many and some even rare species may then be found, but the flowers will have ceased to be a feature of the landscape. The lichenologist will find superb specimens of *Evernia divaricata* in fruit in the forest between Grindelwald and the Rosenlaui glacier.

I regret not having had time to explore the St. Gothard for lichens which are said to be interesting in that region. The rocks below the celebrated Devil's Bridge were covered with *Gyrophoræ*, mostly common species, however. The richest botanical field of Switzerland which the American is likely to visit is Zermatt, at the foot of Monte Rosa. Here, there is enough to catch the eye of the traveller, but the species for which Zermatt is particularly famed must be diligently sought, and one who expects to examine this region profitably must make up his mind to stay at least a week. Interesting plants are found on the road from Visp to Zermatt and, at least, the first half of the way, as far as St. Niklaus, had better be made on foot for that reason. The Riffelberg is interesting in the season but, by the middle of August, not very much is to be found. The *Pinus cembra* of this mountain, and the larches whose trunks are gay with *Evernia vulpina*, are certainly worth seeing.

As far as botany is concerned, Chamounix is very uninteresting, although the lichens are tolerably numerous. The Flegére is almost stupid in its monotony, and the only plant of any interest is the fern *Allosorus crispus*, abundant just before entering the forest. Attracted by the name "le Jardin," I started off early one morning expecting to return laden with treasures. The scenery was magnificent, but the so-called garden is destitute of all but common alpine plants, such as *Gentiana punctata*, *G. Bavarica*, *Linaria alpina*, etc. The excursion on the whole is fatiguing over the *mer de glace* as far as can be seen from Montanvert, then, round a corner of the *Aiguille du moine* to the Telafére moraine, then a horrid climb up the moraine relieved only by the bright flowers of *Adenostytes albifrons*, and across the Telafére glacier to the Jardin; in all, a walk of nine hours over snow, ice and moraines.

Let me now say a word about the books a traveller had better take with him to the botanical districts. I started with Koch's "Taschenbuch der Deutschen und Schweizer Flora," which I found to answer the desired object very well, although it is somewhat antiquated. It is not in print, however, and can only be obtained at second-hand bookstores of the large cities. I had the misfortune to lose my "Taschenbuch"and had some trouble in finding a substitute at Lucerne. Let me warn all your readers against a wretched "Taschenbegleiter des Alpenclubisten" by Dr. R. T. Smiler. One might just as well try to find a plant in Bradshaw's "Railway Guide." At last, in Geneva, I found an excellent little guide called "Flore analytique de la Suisse" by P. Morthier of Neuchatel, second edition, 1872. It is compact and, if only decently bound, instead of being in paper covers like all continental books, would be as convenient as possible. The orders are arranged according to the natural, but the key on the Linnæan, system. The author, it must be remarked, has a very neat way of getting over difficulties in the larger and more complicated genera. The principal species are clearly given and, at the bottom of the page, a note like the following: Between species A and B are several hybrids known as species C, D, E, etc., of different authors. This might certainly be called eliminating difficulties.

Geneva, although long known as the residence of distinguished scientific men, is not, at present, so much frequented by Americans who wish to pursue science as the German University towns. The Academy partakes to a large degree of the nature of a German gymnasium. This is owing, partly, to the absence, until recently, of good practical laboratories which are so common in Germany, and to which that country is indebted for the large influx of foreign students. Recently, however, the new Academy buildings have been finished in a very substantial manner, and the number of laboratories, chemical, physical, anatomical, physiological, botanical, zoological, etc., is quite astonishing. It is said that a part of the large sum bequeathed to the city by the late Duke of Brunswick is to be devoted to improving the Academy and raising it to the rank of a University. I have no doubt this will soon be done, and then Geneva may attract American students, as the beauty of its situation and the opportunities for learning French are two very decided advantages.

Botany is, at present, represented here by M. Alphonse de Candolle and his son M. Casimir and Dr. Johann Müller, called Argoviensis, to distinguish him from the numerous other Müllers, distinguished in botany and zoölogy. M. Edward Boissier resides near the city, and the aged M. Duby a short distance up on the lake. Besides these is a M. Thurie, professor of vegetable physiology. The laboratory of the latter has been recently fitted up. The botanical garden, although forming a very pleasant playground for children and their nurses, is hardly what one would expect from a city in which three generations of De Candolles have lived. It is whispered that the city government prefers to use it as a propagating garden for the supply of the public squares and parks.

In herbaria the city is very rich, there being, at present, three distinct large collections; the De Candolle herbarium opposite the cathedral; the collection of M. Boissier at his residence; and that of Delessert formerly in Paris. The latter is not yet arranged and will be for some time particularly inaccessible. The De Candolle herbarium is in two divisions; the first, from which the earlier volumes of the Prodromus were written, remains as a classic memorial of that work, no additions or alterations being made in it, but all purchases and exchanges are inserted in the second herbarium, which contains the materials of the later volumes.

The curator of the herbarium is Dr. Müller, whom I found on my arrival resting from the fatigue arising from his work on Brazilian Rubiaceæ, by devoting himself to his favorites the lichens. With his assistance I was enabled to study the lichen flora of Geneva. This excellent botanist and most amiable man has an extensive general knowledge of all branches of botany, and does not turn up his nose at the smaller plants as beneath his notice. In his knowledge of lichens he has few equals in Europe, although most of his time is given to the study of phænogams. The Vegetations-punkt mania does not prevail at Geneva as in Germany, where it affects many of the younger botanists to such an extent that they are quite unfitted for practical work. The Germans are constantly making the mistake that everything microscopic is important, in fact more important than anything else.

The flora of Geneva is exceedingly interesting, the city being situated at a point where a northern and southern flora unite. It was too late to study the phænerogams when I arrived, but the lichens are always in season. A short hour from the city is the Pas de l'Echelle leading to the passage between the Grand and Petit Salève. Here is the original station of a number of species of lichens. Along the path one sees rocks and stones bearing marks of the chisel. These were made by Dr. Müller who points out the identical spot where the first *Amphiloma granulosum* was found by him, as well as other new species. Everywhere lichens abound. In the passage above, between the Grand and Petit Salève, the rocks of the two sides bear different species: to the left, the rare *Toninia Boissieri*, *Lynalissa Salivensis* and *Omphalaria pulvinata*, and to the right, many *Verrucariaceæ*. At present, more than a thousand species of lichens have been found in the vicinity of Geneva, a very large number for a local flora. In one spot a number of holes have been drilled into the rocks, and Prof. DeBary one day suggested jokingly, that Dr. Müller was going to blow up the mountain to see if he could not find some new species inside. To show how thoroughly Dr. Müller has explored this region (pointing to a ledge of rocks) he said that he began at one end one Sunday, and examined a certain tract marking the place where he left off, and returned on successive Sundays until the whole ledge was explored. The Eldorado of lichenologists is near the summit of the Grand Gorge on the Grand Salève. Between the fallen boulders at the foot of the mountain is found *Cyclamen Europæum* in abundance, and also the rare fern *Asplenium Halleri* which generally grows with *Solorina saccata.*

On the opposite side of Geneva from the Salève and farther distant are the highest summits of the Jura, the Dôle, Colombier and Reculet. Of these the Dôle is the most accessible. The ascent is made from St. Cergues about three hours distant from Nyon on the lake. The excellent road ascends gradually to St. Cergues and affords magnificent views of the lake and Mt. Blanc. It is from this route that one is best enabled to form a correct idea of the height of the latter mountain which seems to rise higher and higher, while the lower mountains, as the Salève and the Mole sink gradually until they are lost in an undulating plain. At St. Cergues the traveller finds himself in a very primitive region. The doors of the rooms at the inn are destitute of bolts or locks. There being no fire or possibility of a fire except in the kitchen I took refuge in that apartment and looked on in astonishment while the landlady made soup of bread, water and garlics. The "anything warm that I wanted" turned out to be cold Swiss sausage. All that I can forgive, but why would the landlady stand by me while I was eating, and ask if I liked the food? Of course, I had to say it was delicious. The next day, with a gendarmes as a guide, carrying an enormous basket with a very little luncheon, I went to the summit, passing through large forests of *Abies excelsa*, and pastures full of the beautiful *Gentiana ciliata*. The rocks of the summit were covered with lichens, the most striking of which were *Biatora rupestris*, var. *calva*, *Verrucaria plumbea*, *V. Dufourii*, *Blastenia Agardhiana*, *B. nubigena*, *Caloplaca chalybœa* and *Biatora Jurana*. Having disposed of our luncheon, I soon managed to fill the basket, my box, and all my pockets to overflowing, to say nothing of two or three leaves of *Cirsium ferox* covered with a *Puccinia*, and several large agarics which I carried in one hand. The gendarmes did not seem to mind the *Cladoniæ* and *Parmeliæ* much: but I thought his countenance fell as he saw the *Verrucariæ* and other mineralogical plants going into the basket which I kindly allowed him to carry. Returning to Nyon in the omnibus I managed to incommode my neighbors by the specimens in my coat pockets. In my lap was a heap of *Cladoniæ* and *Peltigeræ*, and a worthy Switzer opposite got his feet entangled in the strap of my botanical box, where were my choicest specimens, and I soon saw it moving towards the door bottom upwards with the cover open. But every one was restored to good nature by a young lady, just from Paris, who distributed a package of candy amongst the company.

An interesting locality for lichens is along the Arve above Geneva; but, at the time of my visit, the stones on which they grow were under water. Only in spring can one collect there with advantage. During his excursions in the higher Alps, M. Casimir De Candolle has made some interesting discoveries with regard to the height at which lichens grow. He found on the summit of Monte Rosa (15,217 ft. high) *Amphiloma murorum*. The upper part of the Schreckhorn (13,386 ft. high) is covered with lichens; so far as is known, however, only common species.

REVIEWS AND BOOK NOTICES.

SURVEYS WEST OF THE 100TH MERIDIAN.—We have before us Lt. Wheeler's preliminary report of progress of the geographical and geological surveys, and explorations west of the 100th meridian in Nevada, Utah, Colorado, New Mexico and Arizona. The fourth season of field work was brought to a close in December last, when the parties returned to Washington to elaborate results. These surveys have been made to perfect and supplement each other in such a way that a vast extent of country has been covered in, from central California over a great part of Nevada, as far east as eastern Utah and south including Arizona. The initial work of surveys consists in the accurate mapping out of the public domain lying to the westward of the 100th meridian. To accomplish this, a number of skilled topographers and astronomers have been employed, whose successful efforts can hardly be overestimated in these particular lines. As collateral branches of the work, geology mineralogy, chemistry, botany, ethnology and zoology, all have received due share of attention and large collections have been made, amounting to many thousands of specimens. In addition to these scientific subjects, the questions more especially bearing on political economy have been carefully discussed; such as methods of irrigation, mining, etc., the establishment of military posts, etc. Numerous photographs were taken representing the ancient as well as modern dwellings of the Indians, the geological formations, mountains, etc. A vast amount of manuscript is in hand ready for publication should Congress make the necessary and highly proper appropriations. Probably not less than fifty new species of insects, fish, etc., will be figured in the reports, which will consist of seven quarto volumes besides an atlas of maps, which is already near completion. From the maps we have seen, we judge that they are probably the best of the country ever made. This year's work will consist of labors in the mining district known as *Snab* in Colorado. The *personnel* of the party is nearly the same as heretofore, consisting of the following accomplished officers; among the names will be recognized several well known to naturalists:—Lt. G. M. Wheeler, Corps of Engineers in charge; Lt. W. M. Marshall, Corps of Engineers Astronomical; Lt. R. H.

Hogie, Corps of Engineers Meteorological; Dr. H. S. Yarrow, U.S.A., Surgeon and Naturalist; Dr. J. T. Rothrock, U.S.A., Surgeon and Botanist; Dr. Oscar Loew, Chemist and Mineralogist; H. W. Henshaw, Assistant Naturalist and Ornithologist; besides a corps of trained collectors.

The area gone over in 1873 was no less than 76,000 square miles, and Lt. Wheeler's work has probably not been surpassed for general accuracy and minuteness of detail. Dr. Yarrow's name, as that of the officer in charge of Natural History division of the work, is sufficient guarantee of the highly creditable manner in which that branch of investigation is conducted. His results, to many of which we have already enjoyed access, are of great interest and importance. It is to be earnestly hoped that this great and most important work may not be restricted for want of the funds needed for its completely successful prosecution.—ELLIOTT COUES.

CHECK LIST OF COLEOPTERA.[*]—A new and revised list of our beetles has long been needed, as a convenience in arranging our cabinets and facilitating exchanges. Its publication has also been necessitated by the numerous changes which have been made in synonymy, mostly based on comparisons made by Dr. LeConte in Europe, and others from examinations made by the author. Some important changes have been made in the arrangement of the families, the Coccinellidæ, Erotylidæ and Endomychidæ being placed in the Clavicorn series by Mr. Crotch, an important measure sanctioned by Drs. LeConte and Horn, while the weevils are placed at the end of the series in accordance with the views of Dr. LeConte.

DICTIONARY OF ELEVATIONS OF THE UNITED STATES.[†]—Though of special value to physicians, this book will be useful to those interested in the geographical distribution of plants and animals, as the elevations of many points, particularly in the Rocky Mountains, are given in a compact form. The Dictionary contains in addition to elevations, the latitude and mean annual temperature of many localities. We notice some inaccuracies and omissions in comparing it with "Gannett's List of Elevations" published by Hayden's Survey, those relating to the heights of prominent mountains being inexcusable. These, with typographical and other errors, show that it should be consulted with some caution.

---

[*] Check List of the Coleoptera of America north of Mexico. By G. R. Crotch. Salem, Mass., Naturalists' Agency, 1874. 8vo, pp. 136. $1.00.

[†] Dictionary of Elevations and Climatic Register of the United States; containing, in addition to elevations, the latitude, mean annual temperature, and the total annual rainfall of many localities; with a brief introduction on the orographic and other physical peculiarities of North America. By J. M. Toner, M. D. New York. Van Nostrand, 1874. 8vo, pp. 93. Price $3.00 paper; $3.75 cloth.

Flora of Colorado.*—The inhabitants of the far west and eastern tourists will have reason to thank Dr. Hayden for the useful series of practical manuals of the natural history of the Rocky Mountains he is so energetically pushing on to completion. This synopsis, the first of the series, is very opportune, as it places in the hands of the tourist or botanist a ready means of identifying the plants of a region so rich in interest as Colorado. We only regret that the preliminary essay on the geographical distribution of the Rocky Mountain flora could not have appeared in the same volume.

The plan followed in the synopsis is that of Mr. Watson in his catalogue contained in the fifth volume of "King's Report on the Geology, etc., of the Fortieth Parallel." Descriptions are given of all the plants not mentioned in "Gray's Manual," "Chapman's Flora" and other floras of the eastern states.

The mosses and Hepaticæ have been elaborated by Mr. L. Lesquereux, the lichens by Mr. H. Willey, and the fungi by Mr. Peck, while the name of the author of the larger portion on Phanerogams is a sufficient guarantee of the quality of the work.

BOTANY.

Abnormal form of Allosorus acrostichoides.—On a visit to Isle Royale, Michigan (Lake Superior), in August, 1873, I collected some nice specimens of that peculiar fern *Allosorus acrostichoides* Sprengel (*Cryptogramma acrostichoides* R. Br.). One large handsome plant I succeeded in transporting to Detroit, where it at present flourishes on a rockwork made for the purpose. It affords an instance of a curious abnormality which, I believe, has not hitherto been noticed in this fern. I refer to its producing fronds

---

* Synopsis of the Flora of Colorado. By Thomas C. Porter and John M. Coulter. Department of the Interior U. S. Geological and Geographical Survey of the Territories. F. V. Hayden, U. S. Geologist, in charge. Miscellaneous Publication, No. 4. Washington, 1874. 8vo, pp. 180.

in which the upper part is fertile, having the usual very narrow linear divisions, while the lower part, barren, has all the characteristics of the sterile frond with its "obovate decurrent and crenately toothed or incised segments." The abnormal frond is also quite as tall as the fertile fronds, which in this fern, it is well known, have always much taller stipes than the sterile fronds, lifting them high above the latter.

I was much gratified to behold this dainty graceful fern growing in its native haunts—its isolated home. It was now in full perfection, which was not the case at the time of my first visit to the island, in May. I observed that it generally grew in clefts or on shelves of the outcropping ridges of metamorphosed sandstone, partially shaded by trees, and always facing the south. It was invariably surrounded with a mass of *débris* largely formed of the decayed fronds of numerous previous generations of the fern, while the straw-like stipes of many years remained erect and dry encircling the plant below, and no doubt affording it valuable protection.—HENRY GILLMAN, *Detroit, Michigan.*

RUMEX PATIENTIA L.—This rumex is not mentioned in Wood's Botany, and the brief reference to it in the last edition of Gray's Manual in connection with Amherst, Mass., suggests that it is comparatively rare. It may therefore be interesting to botanists, to know that it is not uncommon in Amherst, and at least three of the neighboring towns, growing by the roadside or near dwellings. And when the writer was at Highgate Springs in northwestern Vermont during the past season, it was everywhere as abundant and apparently as much at home as any of our introduced rumices.—H. G. J.

THE NORTHERNMOST FLOWERING PLANTS.—Dr. Bessels, of Hall's Arctic expedition, collected according to a note in "Nature" by Dr. J. D. Hooker, four plants from the east side of Smith's Sound in latitude 82° N. They are *Draba alpina* L., *Cerastium alpinum* L., *Taraxacum dens-leonis* Def. var. and *Poa flexuosa* Wahl. This is the most northern locality where any phanerogamous vegetation has been found.

THE SMALL-FLOWERED PARNASSIA IN MICHIGAN.—In the summer of 1866, I made the interesting discovery of the small-flowered grass of Parnassus (*Parnassia parviflora* DC.), at White-fish Bay, Wisconsin, on the northwest shore of Lake Michigan. The elegant little plants grew in patches of moss, in clefts of the rock, within reach of the spray from the lake.

As I was the first to discover this flower on Lake Michigan (in Wisconsin), so now, I believe, I am the first to find it in the state of Michigan, and thus have the pleasure of adding to its flora this somewhat rare plant. I found it to-day (August 1, 1873), growing rather abundantly on Grand Island, Michigan, along the high cliffs of red Potsdam sandstone overhanging Lake Superior. At this date some of the plants are in full flower, others have gone to seed, while a number have flower-buds still unexpanded.

I wish to call attention to the number of the sterile filaments in each set — so specific a distinction in this genus. Gray gives the number in *P. parviflora* as "about five in each set," which corresponds, I think, with other descriptions. In a large number of specimens which I have to-day carefully examined, I find the sterile filaments from six to nine, and occasionally eleven in each set; but oftenest they are seven. This about agrees with my Lake Michigan plant. The flower is from five-eighths to three-fourths of an inch broad; and the petals are decidedly (generally one-fourth to one-third) longer than the calyx. The ovate or rather oblong leaves are somewhat heart-shaped at the base.

These Lake Superior plants, growing mostly on the soft and disintegrated sandstone, are of more luxuriant appearance than my specimens from Lake Michigan, which grew on limestone rock. I observed that matlike tufts of the plant, which had fallen from the beetling cliff, frequently took root and flourished on the beach below; though, doubtless, they are in such cases often swept away by the fierce waves of Lake Superior.

It seems to me that the Parnassias would make interesting garden plants, and prove easy of cultivation. Their cup-like flowers, of a delicate white finely veined with green, could not fail to be considered ornamental; while the lengthy period of blossoming would be an additional recommendation. — HENRY GILLMAN, *Detroit, Michigan.*

THE FRESH WATER ALGÆ OF NORTH AMERICA.—Students of our fresh water algæ will find in the beautiful and interesting work of Dr. H. C. Wood, Jr., "A Contribution to the History of the Fresh Water Algæ of North America," a ready means of identifying their specimens. It is a large quarto volume, with many colored plates, and is taken from the Smithsonian Contributions to Knowledge.

Aplectrum hyemale again.—Of the thirty plants of *Aplectrum hyemale* Nutt., transferred to my garden from the woods north of Detroit, on the 20th of April, 1873, mention of which has already been made in the Naturalist, but two sent up flower scapes and of those but one came to perfection. The petals of this expanded on the 5th of June. The other scape proved abortive, the raceme not appearing from the sheath.

At the date of October 1st most of the new leaves of my plants were from one inch to three inches above ground, while some were only just protruding from the earth. The plants seem to be quite healthy.

Numerous communications, received from various places since the printing of my note, are mostly confirmatory of the opinion I had arrived at as to the rarity of the blossoming.

As a generally accepted opinion is that this plant is not found in Massachusetts, I would here say that I have lately been informed on reliable authority that there is but one known station for it in that state, viz., Amherst, where for two or three seasons it has been collected in flower.

I omitted mentioning in my former note that on June 30, 1870, I collected in our woods a single withered scape with pods, of the previous season, showing that the plant had flowered there in 1869.—Henry Gillman, *Detroit, Michigan.*

Development of Ferns without Fertilization.—At a late meeting of the American Academy of Arts and Sciences, Prof. Gray communicated a paper by his former pupil, Dr. W. G. Farlow, now in Germany, on the development of ferns from the prothallium irrespective of fertilization, by a sort of parthenogenesis. The growth observed took place, not from an archegonium, but from some other part of the prothallium.

Lobelia syphiliticæ var. alba.—In 1868 I found near Princeton, N. J., a single plant of *Lobelia syphilitica* v. *alba*, which must be very rare in this country. It was found among many other plants bearing blue flowers—though in this case they were *perfectly* white—and continued to bear white flowers for three years as did also the seedlings from this plant. After this time I lost sight of the plants. Paxton (Bot. Dict.) instances the var. alba, but American authors do not look upon it as a permanent variety.—J. S. Hough.

ZOOLOGY.

Olive-sided Flycatcher.—In the December number of the Naturalist Mr. C. Hart Merriam, in remarking on *Contopus borealis*, states, that he obtained a fine specimen at Easthampton, Massachusetts, and asks if this species has ever been taken in Massachusetts before.

During the past three or four years I have observed each year several specimens of this beautiful flycatcher in the vicinity of Cambridge, Mass., and although I consider this a rare bird with us, I am inclined to think a few breed within the limits of the state every year. I have always observed it in May or June, though specimens have been captured here in the fall.

With us it is a very wary and shy species when it first arrives from the south, frequenting the topmost branches of tall trees, and its mild, clear notes can be heard at a long distance, but at the Umbagog Lakes, in Maine, where it breeds in numbers, it does not show nearly so much shyness as it exhibits during its northern migrations through Massachusetts. I have taken several specimens there in the course of a few hours.

On the 23d of June, 1873, I had an unusual opportunity of observing a pair of *Contopus borealis* in Belmont, Mass. For several days previous I had heard one of the flycatchers uttering its peculiar call from a hillside which was sparsely covered with firs.

On the above date, as I was passing that locality, I again heard the notes of this bird in nearly the same place, and thinking it must be breeding I approached in the direction of the sound, and soon saw the flycatcher in question sitting, in its erect posture, on the top of a small fir tree. I was surprised at the near approach it allowed me, as I was within a few yards of the tree before the bird took flight, though but for a short distance, however, as it alighted on the dead branch of a maple a few yards off, and was then joined by its mate. I then secreted myself in a clump of barberry bushes where I remained for some time watching them.

From the uneasiness the birds exhibited, I was convinced they had a nest in the immediate vicinity, though the locality was not particularly adapted for breeding, but although I searched diligently I was unable to find the nest. I am aware that there have been several nests found in eastern Massachusetts, though this must certainly be its most southern breeding range.

I have thought the species must leave us on their southern migration by the first of September, though I saw one specimen at Moosehead Lake, Maine, as late as the 1st of Oct., 1873, at which period the weather was quite cold, water freezing round our camp most every night.—RUTHVEN DEANE, *Cambridge, Mass.*

THE OLIVE-SIDED FLYCATCHER.—At the close of an article on *Contopus borealis*, which appeared in the December number of the NATURALIST (page 750), I made the inquiry "Has this species ever been obtained in Massachusetts before?" Since then I have ascertained that specimens of it have been collected in eastern Massachusetts by Mr. C. J. Maynard, Wm. Brewster, Esq. and others, and that it occasionally breeds within the state.

In addition to the note previously described, Mr. Nuttall said: "The female had a whistling, oft-repeated, whining call of *'pŭ 'pŭ*, then varied to *'pŭ 'pĭp*, and *'pĭp 'pŭ*, also at times *'pĭp 'pĭp 'pŭ*, *'pĭp 'pĭp 'pĭp*, *'pŭ 'pŭ 'pĭp*, or *'tŭ 'tŭ 'tŭ*, and *'tŭ 'tŭ*. The male, besides this note, had, at long intervals, a call of *seh 'phèbēē* or *'h 'phebéă*." It is such a difficult undertaking to represent accurately the note of a bird by means of letters, that no two persons describe that of the same species by the same characters, although when pronounced, the syllables generally give the same sound. Thus Mr. Nuttall's call of *'h 'phebéă* is undoubtedly the same as that described by myself as *O whéŏ*. His imitation of the note of the female bird is most excellent: I have heard it many times and omitted giving it only because I neglected to write it down while in the field, and it will never do to trust to memory for such matters.—C. HART MERRIAM.

MICROSCOPY.

ON THE STRUCTURE OF DIATOMS.—It is hoped that the publication of the following memoranda will serve the double purpose of elucidating the structure of the tests, and at the same time demonstrating the utility of microscopical objectives of exceptionally high powers. The uncertainty of the footing in this unstable and contested ground will necessitate many errors, and may serve as an excuse for them. So many competent microscopists have written upon this subject that the writer would fain be silent were it not for a firm belief in the superiority of the instrument he used, for this kind of investigation. In fact this excellent glass gives advanced work on almost every test tried, and fully justifies the confidence reposed in it. The observations recorded below, unless where otherwise stated, were made with a Tolles' $\frac{1}{50}$ immersion objective of 165° angle of aperture, and generally a Tolles' two inch eye-piece, giving an amplification of 2500 diameters.

Eupodiscus Argus.—My attention was especially called to this shell by having noticed the wide difference between the views of Mr. Henry J. Slack, Mr. Samuel Wells and Mr. Charles Stodder. My observations are corroborative of the idea of two plates as asserted by Messrs. Stodder and Wells. Using a $\frac{2}{3}$ objective with power of 340 times obtained by high eye-piece and extending draw tube, and using a Lieberkühn, the outside or coarser markings on specimens mounted convex side uppermost are white with white cloud illumination. An erased space on one shell and the holes or depressions through which Slack's four large "spherules" are seen are now black. They, then, are not covered by the external "crust."

The slide was then turned over and the inside of the same specimen examined by the same method, and on the more favorable portions of it the finer net-work of the *inner plate* is also seen in white, the "spherules" being perfectly black. By this reflected light the "four spherules" are plainly seen to be dark openings in the white plate and the net-work is clearly traced across the areolæ in the outside plate. The diatom looks like a piece of coarse white netting laid over a finer piece.

Under the Tolles' $\frac{1}{50}$ and with transmitted light, whether central or oblique, it matters not, all portions of the surface of both the upper and the lower plates are found to be covered with, or composed of, a *still finer net-work* with irregular oval meshes like the two coarser ones.

The place in the shell above referred to, where the layers are erased, denuding an interior structureless "vail," gives an opportunity to observe the edges of the fractured layers. The broken edges of both plates bordering on the erasure show the jagging of this finest net structure. The arrangement of the finest areolæ is more regular near the margin of the diatom or appears so by reason of the simpler character of the structure in that part. They are easily seen with the $\frac{1}{50}$ on any part of every specimen studied, but are unusually distinct between the "four spherules" on the inner plate looking through the largest openings in the outer plate; or may be rendered still more distinct on shells with the concave side up. They are more difficult to be seen on the outside crust with the high powers used because of its greater opacity. Deductions from focal changes with reference to the various markings lying in different focal planes corroborate the conclusions above expressed.

The disks examined are on Möller's Probe-Platte and on a slide prepared by Mr. Wells.

Hyalodiscus subtilis Bailey.—On this beautiful little shell the "engine rulings" are readily seen with almost any illumination, and the inevitable concomitant of intersecting lines, whether real or illusory beading are displayed. When we use monochromatic light the whole scene is changed. The hyaline portion of the disk is instantly resolved into perfectly well defined hexagons, radiating from the central nucleus. The central part because of its greater depth and complexity is only resolved into irregularly shaped spaces of a more or less hexagonal form. Every one of the five beads usually seen represents the centre of an hexagonal plane exactly as in *Pleurosigma angulatum*.

The hexagons are well defined with a power of 7,000 diameters. They may also be seen with lamp or daylight.

Triceratium favus.—The two sets of markings on this fascinating object certainly lie in different focal planes (see Carpenter, "The Microscope," 4th ed., p. 282 and note) and probably "belong to two distinct layers." The coarse hexagonal ridges are found to project from the outer or convex surface, and the inner plate bears the minute markings. This is proved by the fact that the fine markings show decidedly the plainest on valves that are mounted with the interior surface uppermost.

Under this superior objective the finer markings like the larger are distinctly faveolate. Their hexagonal structure is easily seen even with lamp illumination. When examining comparatively thick shells, possessing a complex structure, like the one in question, the necessity for avoiding errors caused by too intense or by excessively oblique light becomes at once apparent. The unequal refraction of the light in passing through the external siliceous layer produces a distorted image upon and of the interior surface. In this manner distorted small hexagons may be seen along the lines of the larger net-work by a lens incapable of clearly displaying the minute hexagonal markings above described.

The best results are obtained on the *T. favus* with a moderate light nearly central.

Surirella gemma.—This beautiful form has been subjected to all the different conditions of illumination in my possession. Like other relatively thick shells the appearances presented by the markings vary greatly with the changing conditions of observation. No trouble is experienced in bringing out the longitudinal striæ, nor in making the little beauty *seem* to "wear beads." At times the beads give place to rectangles, and again after careful manipulation to sharply defined elongated hexagons ("The Microscope," Carpenter, page 182). Hartnack's hexagons as figured are too much elongated; although sometimes such an appearance is presented when the illuminating pencil is at right angles with the median line, the transverse lines being less distinctly perceptible. When the light is so arranged as to show every side with equal perfection the form of the markings is nearer that of regular hexagons.

The Amici prism is found to work excellently on the *Surirella*, and when it is used with the $\frac{1}{50}$ objective and the blue cell the slightly elongated hexagons are easily exhibited on an average frustule.

Aulacodiscus Kittonii.—This splendid disk is traced with easy angular figures evidently elevations and the spaces between the lines are undoubtedly depressions. Some of the markings are circular, others square, some pentagonal, some hexagonal and others heptagonal. Broken specimens of *Brightwellia Johnsonii* with like surface markings show the line of fracture running through the areolæ.

Navicula rhomboides.—Individual frustules of this species vary considerably in degree of difficulty of resolution. Some of the smallest valves when mounted in balsam tax the powers of excellent instruments. The writer has found all specimens whether mounted dry or in balsam to yield readily transverse striæ with oblique illumination direct from the lamp. Under the same conditions an average valve exhibits well defined longitudinal striæ.

With the ammoni-sulphate cell it is instantly and clearly shown covered in every part with squares, like *Pleurosigma Balticum.*

Navicula crassinervis.—The specimens of this variety, in my possession, are more difficult than *Frustulia Saxonica* and even rival *A. pellucida* under lamp illumination, but any clean frustule is satisfactorily resolved.

Using monochromatic light with plain mirror and Wenham's paraboloid, *longitudinal* lines are discovered. After careful manipulation both sets of lines are seen at the same time, and an appearance of beading results.

Navicula cuspidata.—Both sets of lines are easy, but the longitudinal are much closer together than the transverse. Consequently the light interlinear spaces are elongated and no semblance of beading is to be seen. In diatoms where the intersecting striæ are of nearly equal fineness the little square spaces, when not well defined, seem circular, and if the illumination by transmitted light is intense they present a raised appearance due to refraction.

Mr. Charles Stodder called my attention to this diatom with the view of ascertaining with the $\frac{1}{50}$ whether or not the two sets of lines lie in different focal planes. My observations many times repeated have convinced me that they are never both in focus at the same time, and further that the longitudinal lines are on the external surface and the transverse on the internal plate. If there are not two plates the lines may be on opposite surfaces of the same plate.

White cloud illumination is found to be much better than other and more brilliant light for demonstrating these slight differences in focal distances. Many errors of interpretation are avoided by using an approximately central pencil when the instrument used is capable of elucidating all the details of structure without greater obliquity.

Frustulia Saxonica.—In addition to my observation of longitudinal lines upon this test and resolution into dots (NATURALIST, July 1873, page 443) it may be worth noting that even with lamp illumination the $\frac{1}{50}$ has displayed the transverse much clearer than they appear in Dr. Woodward's photo-print. (Lens, vol. i, p. 197.) With oblique light direct from a small German student's lamp, without mirror, prism or condenser of any kind, a person entirely unaccustomed to the microscope could distinctly see them with

Beck No. 3 eye-piece, power 7,000 times. With the ammoni-sulphate of copper cell the longitudinal lines and dots are displayed with ease.

This is one of the most difficult test diatoms thus far studied, ranking but little easier than *A. pellucida*, *N. crassinervis* and *Nitzschia curvula*.

Amphipleura pellucida.—Many times the writer has been able to confirm the observations of longitudinal lines on this most difficult test shell, but never has succeeded in seeing the dots except with the blue cell and Wenham's paraboloid, and only then under favorable circumstances. (See I. E. Smith, in "The Lens," April, 1873, page 115. See also the NATURALIST, May, 1873, page 316.) When resolution is effected, the dots are exceedingly minute and uniform in size, showing as mere points of light when magnified 2500 times. On one occasion the writer has seen fine dark lines crossing between the transverse striæ like the steps of a ladder, the dots or spaces plainly longest in direction parallel with the median line, proving the longitudinal to be finer than the transverse lines.

One obstacle in the way of resolution of the longitudinal striæ is the presence of diffraction lines. The valves being so narrow increases this difficulty. Only after much time is wasted, and after many discouraging failures, will the patient observer receive the reward of success.

Nitzschia curvula Sm.—The unusual number of spurious appearances in this object leads me to suspect that it possesses a complicated structure as yet beyond the reach of the instrument. The extreme fineness of the longitudinal lines as compared with the transverse reminds one of the *Navicula cuspidata*, and as is the case with the coarser shell, no efforts avail to develop a semblance of beading.

Striatella unipunctata.—Two sets of fine lines, and as the direction of the light is changed, may be made to exhibit either beads or squares. In point of value as a test will be found to approach *Surirella gemma*.

Grammatophora.—Of this genus the writer has examined the *G. marina*, *G. subtilissima* and *G. serpentina*; all of which are resolved into hexagons. Broken specimens of *G. marina* show the line of fracture running through the hexagonal planes and leaving points of the net-work projecting. The markings continue completely illustrated as the stage is resolved, in whatever direction the beam of light may fall.

Stauroneis.—Some of the larger varieties of *S. phœnicenteron* are covered with hexagonal areolæ easily exhibited with central daylight. The projecting points of the fractured partitions between the hexagons may be observed.

Pleurosigma angulatum.—Hexagons. The line of fracture generally running around them, but quite often through them.

Pleurosigma Balticum.—A drop of water slowly advancing by capillary attraction shows this shell to be covered with squares, and proves that both sets of lines forming the boundaries of the squares are on the same surface of the valve; and the appearance presented by an air bubble on the other side proves that surface to be smooth.

Pleurosigma formosum.—Near the ends of the frustule it is easy under certain adjustments of the light to make it appear like a checker-board with alternate bright red and green squares. Double rows of green and red beads alternating may be seen on this as well as on other species of the same genus. (Dr. Pigott in M. M. Journal.) When we resort to central light from a white cloud, and thus lessen the liabilities to err caused by refraction, diffraction, decomposition of light, and oblique projection of shadows, the conclusion is arrived at that these various appearances are caused by two sets of intersecting diagonal ridges, the finer ridges running up and down over and between the coarser, and subject to considerable variation even on the same frustule. This theory would also account for the "beads"(?) being of different colors, and the same "beads" changing color when the focus is changed. We see in many of the mollusks shell-markings of a similar character.

Concluding remarks.—It would seem that the perfect box-like form of the shells of the Diatomaceæ and their elaborate ornamentation would exclude the idea of a blind process of chemical crystallization. Analogy should teach that they are secreted for a protective covering for the tender animal-like plant, as among higher forms. If this is true the surface markings ought to be so distributed as to give additional strength to the shell without greatly adding to its weight. It would also be expected that some of the larger shells would be perforated with holes. This idea, of course, would have to admit into the discussion considerations of habits of growth, and environments. Those contained in gelatinous envelopes should be less developed in strength of shell and bracing. Those growing on algæ and in exposed localities should be strong to resist fracture. On those moving free the bracing would be in proportion to the weakness of the shell; larger shells being relatively more liable to be broken. Here as elsewhere nature without waste of material combines utility with beauty.—G. W. MOREHOUSE.

UNMOUNTED OBJECTS.—At the request of a number of microscopists, Mr. Jno. H. Martin, of the Maidstone Micro-assay Laboratory, has decided to establish an agency in this country for the distribution of his well-known unmounted objects. Persons desiring to prepare their own objects can thus obtain a large variety of interesting materials at a very small cost. A stock of objects will be kept for immediate distribution, and articles that may be out of stock furnished as soon as they can be obtained from abroad. Lists and objects can be obtained by addressing, by post, C. A. BALDWIN, *Troy, N. Y.*

NOTES.

A RARE opportunity is offered botanists or scientific institutions of purchasing the cryptogamic herbarium of Dr. Duby (author of Botanicon Gallicum, etc.), containing the cellular cryptogams of all families except the mosses.

This collection contains first, in eighty-five packages, the herbarium of Dr. Wallroth, and includes all the species discovered by this savant and published in his "Cryptogamia Germanica," also that of Nees von Esenbeck, containing the cryptogamic species of the different families (except the lichens and Hepaticæ, which will be mentioned farther on), including a large number of fungi (among others almost all the species of Schweinitz), algæ, etc., etc. Besides these are eighty large packages containing the fungi either gathered or received by himself. Among th
number are found the Hypoxyla in perfect order, enriched b
authentic specimens from Fries, Montague, Fückel, Berkele
Currey and Bischoff, perfectly named by them. In these pac
ages are found, among other things, the Lycoperdinei, Hyster
Uredines, Mucedines, etc., described in his "Botanicon," or ot
publications. Of exotic fungi the herbarium contains the spe

of Carolina, published by Mr. Curtis; those of Java, collected by Mr. Zollinger, at Junghuha; those of Bahia, by Mr. Blanchet; those of Mexico, Guadaloupe, etc., etc., and a large number that have not yet been published.

As to the lichens, there are thirty-five or forty enormous packages classified by genera, in which are contained not only all those which have served for his "Botanicon Gallicum" but those of Nees v. Esenbeck, Flowtow and others; besides large invoices of exotic and European lichens from Nylander, Körber, Zollinger and others. The Hepaticæ of Nees on which the genera and species of the Hepaticology of this savant have been established, not perfectly in order, are contained in twenty-six packages, classified and labelled, and one package not classified. Lastly the algæ, studied with the greatest care, for his "Botanicon" and subsequent works, either by himself or Mr. Cronan of Brest, enriched with a large number of drawings, composing thirty-five to sixty packages, in which are comprised the algæ of Australia, Ceylon, the Pacific, United States (by Harvey); other specimens from various countries sent by various savants; the microscopic species of Brebisson and other micrographers. To all this must be added twenty-four cartons from M. Lamy de Perignam, containing many different cryptogams, studied and named by M. Montague, de Brebisson, etc.

All these treasures which he has been accumulating for fifty years, and prepared for special work of his own, but which the study of bryology has caused him to abandon, he will sell for five thousand francs.

As to the *mosses* the collection is still larger, but he will only sell it on condition that it shall remain in his hands during his life.

We hope the time is coming when rare scientific treasures like these will be presented either to the Cambridge, or some other accessible herbarium in the United States, by generous persons of means.

We reprint, from the "N. Y. Tribune," a portion of the report by Prof. E. Weiss of Vienna, who visited this country in 1872 for the purpose of acquainting himself with the condition of practical astronomy in the United States. The extract well represents some of the causes that retard original investigation in the United

States, and applies as well to biology as to astronomy. We look with a sort of dismay upon the future of biological science in America, so few are the earnest, self-sacrificing students who are devoting themselves to histology, embryology and experimental biology. When the fortunate moment arrives, that our flora and fauna are worked up, we hope for what the French would call *serious* work. Meantime the appeals now before the public, in behalf of the Anderson School of Natural History and the Zoological Museum at Cambridge, we trust will produce good results.

"On the other hand, of much greater importance is it that, in general, almost all scientific institutions in America feel the want of workers of every kind, and, in many cases, this want arises not so much from financial as from social relations. For the number of men who devote themselves to the service of science in America is very small, not only because the pursuits in other paths are far more profitable, but especially because the efforts of every young man are concentrated in the endeavor to earn his own livelihood as soon as possible. This latter trait of character, which most frequently hinders the pursuit of year-long earnest studies, is certainly the fundamental reason why scientific growth does not correspond to the necessities. This is the case, notwithstanding the fact that Americans are in no way disinclined towards the sciences, but, on the contrary, very highly esteem both them and the men that cultivate them, as is shown by the above-mentioned numerous gifts of private individuals for the improvement of the existing, and the establishment of new schools and scientific institutes. Furthermore, most institutions suffer from an almost constant deficiency of persons to execute the subordinate drudgery; and that, again, because of a national peculiarity. For an American would rather subject himself to the severest bodily labor for days' wages, than to enter anywhere as a servant for a long period; since, in the latter case, he must obey the orders of his master, and this he views as a deprivation of his individual freedom."

MAX SCHULTZE, the distinguished German anatomist and histologist, is dead. He was the editor of the well known "Archiv für Microscopiche Anatomie," devoted largely to the anatomy of the tissues and to the infusoria. He wrote also on the embryology and anatomy of the worms, of echinoderms and hydroid medusæ, and on the foraminifera. He was born in 1825, and died, in the prime of life, at Bonn, having just had completed for his use, as is said, the amplest and most elegantly constructed laboratory in Europe.

THE "Miscellaneous Publications" of the U. S. Geological Survey of the Territories are as follows. No. 1. List of Elevations west of the Mississippi, by H. Gannet. 2. (Unpublished). 3. Ornithology of the Territories, by Dr. Elliott Coues (to be issued in May). 4. Synopsis of the Flora of Colorado, by Porter and Coulter. 5. Descriptive Catalogue of Photographs of the survey, for the years 1869 to 1873, inclusive.

THE Boston Society of Natural History is to republish Hentz's papers on North American Spiders, to be edited by Mr. E. Burgess, with notes and two new plates by Mr. J. H. Emerton, as No. 2 of the "Occasional Papers." The work will contain about one hundred pages, and have nineteen plates, and the price will be $3.00 or $3.50.

IN the April number of the NATURALIST I find my name appears as the botanist of the Wheeler expedition of 1873, to the exclusion of my good friend Prof. John Wolf. This has been by accidental omission, I am sure, on the part of the writer of the article in question. I did have a certain connection with the botanical collection, but the bulk of the work done in that department was by Prof. Wolf, whose conscientious labor cannot be too highly commended.—J. T. ROTHROCK.

THE friends of the late Professor Agassiz, the friends of education, propose to raise a memorial to him, by placing upon a strong and enduring basis the work to which he devoted his life, the Museum of Comparative Zoölogy, which is at once a collection of natural objects, rivalling the most celebrated collections of the Old World, and a school open to all the teachers of the land.

It is proposed that the teachers and pupils of the whole country take part in this memorial, and that on the birthday of Agassiz, the 28th day of May, 1874, they shall each contribute something, however small, to the Teachers' and Pupils' Memorial Fund, in honor of Louis Agassiz; the fund to be kept separate, and the income to be applied to the expenses of the Museum.

All communications and remittances for the "Teachers' and Pupils' Fund" of the "Agassiz Memorial," may be sent to the Treasurer, James M. Barnard, Room 4, No. 13 Exchange Street, Boston.

Will not every subscriber to the NATURALIST contribute his or her mite to this great object?

THE Anderson School of Natural History will open July 7 and close August 29. We learn that over ninety applications have been made above the number which can be accommodated. This in itself is an appeal to the people to sustain the school. The funds of the school are nearly exhausted in erecting the buildings and preparing the necessary outfit. The Director of the school, Mr. Alexander Agassiz, now asks the coöperation of all interested in education in obtaining from the Legislatures of their respective states, or from other means at the disposal of State Boards of Education, a moderate appropriation say of $5,000, or an annual grant of $350, as a contribution towards the permanent support of the Anderson School. Every such share would entitle each state participating to the admission of two teachers annually as students at Penikese.

The following gentlemen will have charge of instruction in their respective departments:—Prof. B. G. Wilder (Vertebrates), F. W. Putnam (Fishes), A. S. Packard (Articulates), Profs. E. S. Morse and Hamlin (Mollusks), E. Bicknell (Microscopy), while lectures will be delivered by Mr. A. Agassiz on Radiates and Embryology, Prof. A. M. Meyer, on Physiological Physics and Mr. Theodore Lyman on Pisciculture. The laboratories will be in charge of Mr. Garman. Dr. Packard and Mr. Garman will take charge of the dredging expeditions.

BOOKS RECEIVED.

Agassiz. A Lecture delivered before the Louisville Literary Association by J. P. Luse, Feb. 16, 1874. 8vo, pp. 38.

Einundzwanzigster Bericht des Naturhistorischen Vereins in Augsburg. 8vo, pp. 138. Augsburg, 1871.

Bulletin Mensuel de la Societe de l'Acclimatation. 8vo, vol. 10, Nos. 10 and 11, 1873. Paris.

Proceedings of the Imperial Botanical Garden of St. Petersburg. 8vo, vol. 1, Pt. 2, 1872. Vol. ii, Pt. 1, 1873.

Archiv fur Anthropologie. 4to, vol. vi, Pt. 3. Braunschweig, 1873.

Festschrift zur Feier des Hundertjahrigen Bestehens der Gesellschaft Naturforschender Freunde zu Berlin. 4to vol., pp. 264, with 20 plates. Berlin, 1873.

Jahrbuch der Kaiserlich-koniglichen geologischen Gesellschaft. 8vo, vol. xxiii, No. 2, 2 plates. Wien, 1873.

Horae Societatis Entomologicae Rossicae. 8vo, vol. viii, Nos. 3 and 4, 2 plates. Vol. ix, Nos. 1 and 2. St. Petersburg, 1871 and 1872.

Bericht der oberosterreichischen Handels-und Gewerbekammer zu Linz. 8vo. Linz, 1872.

Statistischer Bericht der Handels-und Gewerbekammer Oberosterreichs zu Linz nach den Ergebnissen des Jahres 1870. Linz, 1872.

Summarische Berichte betreffende die Verhaltnisse der Industrie, des Handels und Verkehres Oberosterreichs im Jahre 1871, 1872. Linz, 1872, 1873.

Compte-Rendu de la Societe Entomologique de Belgique. 8vo, No. 96, pp. 12.

Notes on the Avifauna of the Aleutian Islands, especially those west of Unalashka. By W. H. Dall. 8vo, pp. 12. (From Proc. Cal. Acad. Sciences, 1874.)

Contributions to the Study of Yellow Fever. By J. M. Toner and John M. Woodworth. 8vo, pp. 51. Washington, 1874.

Department of the Interior, U. S. Geological and Geographical Survey of the Territories. Miscellaneous Publications; No. 4, Synopsis of the Flora of Colorado. By Thomas C. Porter and John M. Coulter. 8vo, pp. 180. Washington, March 20, 1874. *No. 5, Descriptive Catalogue of the Photographs of the U. S. Geological Survey of the Territories for the years* 1869 *to* 1873 *inclusive.* W. H. Jackson, Photographer. 8vo, pp. 83. Washington, 1874.

Jenaische Zeitschrift fur Medicin und Naturwissenschaften. 8vo, Bd. i, Hefte 1-4; Bd. vii, Hefte 1-4. Leipzig.

THE

AMERICAN NATURALIST.

Vol. VIII.—JUNE, 1874.—No. 6.

THE PRESERVATION OF CATERPILLARS BY INFLATION.

BY SAMUEL H. SCUDDER.

MANY persons are deterred from collecting caterpillars, by the difficulty and expense of preserving them in the ordinary way. The easy and inexpensive method of blowing up and mounting the pellicle is so little known in this country, that at the last meeting of the American Association, only one entomologist besides myself had ever seen the operation; since then, others have tried it and been delighted with its simplicity. In the hope of inducing all our entomologists to experiment for themselves, the following explanation of the process has been prepared.

It should be premised that caterpillars may be prepared in this way so as to retain their colors far better than by any other method and often to be fit subjects at any subsequent time for the artist's pencil; the most delicate processes may be preserved uninjured, and the examination of hairy or spiny appendages made even more readily than during life. Specimens taken from spirits, unless absolutely naked, are always difficult to examine from the matting of the hairs; and the internal organs can seldom be studied, even in the rudest manner, unless the greatest care has been bestowed upon their preservation; in fact, no specimen can be fitted by any process, for the study of both internal and external organizations, and for the latter, no method of preparation compares with that of inflation.

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

The instruments necessary for the operation, besides the tools in the hands of every entomologist, are a small tin oven, a spirit lamp, a pair of finely pointed scissors, a bit of rag, a little fine wire and a straw.

The oven is simply an oblong tin box, about 2½ inches high, 2½ inches wide and 5 inches long; the cover is of glass, and one end of the box is perforated by a circular hole 1¼ inches in diameter. It would be well to have this end of glass, and the opposite end should be movable; the oven rests upon an open standard of twisted wire or riveted tin plates, as in the woodcut (Fig. 76). No soldering should be used upon the oven or standard, as it would soon be melted. Mr. Riley suggests that there would be an advantage in having the front end of the standard higher than the back as he has shown in the sketch. He also proposes a movable wire loop indicated in the woodcut by the dotted line;* but this would seem superfluous.

Fig. 76.

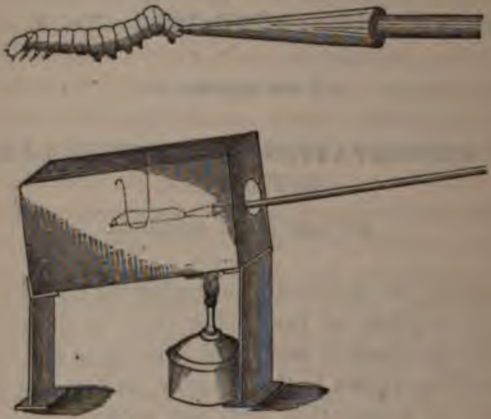
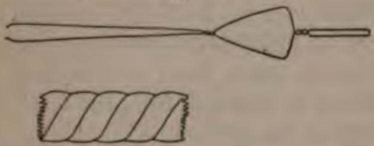


Fig. 77.



The wire should be very fine and annealed; the best is that wound with green thread and used for artificial flowers. It should not be more than half a millimetre in diameter; the cut represents it magnified nineteen diameters (Fig. 77).

---

* The engraver should have made this loop hang from the edges of the oven.

The straw. Mr. Goossens of Paris, my courteous instructor in this art, who possesses a collection of nearly a thousand species of inflated caterpillars, uses nothing but ordinary wheat straw, choosing stout, dry pieces of various sizes, the cross section of which is perfectly circular; with these he inflates the smallest micros and the largest sphingidæ. Various modifications have been suggested; a glass tube drawn to a fine point, and provided with a pair of spring clips to attach to the caterpillar, is a favorite form; the Germans use this largely, and sometimes attach the caterpillar by threads passed around the anal prolegs. Dr. LeConte informs me that Dr. Gemminger uses a finely pointed tube with an elastic bulb attached like a rubber syringe. Mr. Riley suggests (as his drawing represents) still another mode, which is to pierce a piece of soft wood along the grain with a fine heated wire and then sharpen to a point the tube thus formed, to be inserted in the caterpillar; a tube is also inserted in the other end (see Fig. 76). For myself I prefer the simple straw.

The operation. Kill the subject by a drop of ether or by a plunge in spirits; if it be a hairy caterpillar it should remain at least half an hour in alcohol and then rest on bibulous paper for forty-eight hours; otherwise the hairs drop off in the subsequent operation. Then placing the caterpillar in the left hand, so as to expose its hinder extremity beyond the gently closed thumb and first two fingers, enlarge the vent slightly at the lower edge by a vertical cut with the scissors; next lay the larva either upon bibulous paper on the table, or upon soft cotton cloth held in the left hand, and press the extremity of the body with one finger, always with the interposition of cloth or paper, so as to force out any of the contents of the rectum; this process is continued from points successively farther back, a slight additional portion of the contents of the body being gently pressed out with each new movement; throughout all this process, great care should be taken lest the skin should be abraded by too violent pressure, and lest any of the contents of the body soil its exterior or become entangled in the hairs or spines; to avoid the latter, the caterpillar should be frequently removed to a clean part of the cloth or paper. When a portion of the intestinal tube itself becomes extended it should be seized with a pair of strong forceps, and, the head remaining in the secure hold of the left hand, the tube should be forcibly but steadily torn from its attachments; with this, most of the contents of the body will be withdrawn and a delicate pressure passing from the head toward the tail will reduce the subject to a mere pellicle.

The alcohol lamp is now lighted and placed in position beneath the oven; a straw is selected, of the proper size to enter the enlarged vent, and the tip, after being cut diagonally with sharp scissors, is moistened a little in the mouth (to prevent too great adhesion of the skin to the straw) and carefully introduced into the opening of the caterpillar; the process may be aided by blowing gently through the straw. When the skin is slipped upon all sides of the straw to the distance of nearly a quarter of an inch, without any folding of the skin and so that both the anal prolegs protrude, a delicate pin (Edelston and Williams, No. 19, is best) is passed through the anal plate and the straw.

By this time the oven will be sufficiently heated to commence the drying process, which consists simply in keeping the caterpillar in the oven extended horizontally upon the straw by blowing gently and steadily through the straw, as one uses a blow-pipe. Too forcible inflation will make the caterpillar unsightly by distending unnaturally any spot that may have been weakened or bruised in the previous operation; the caterpillar should be kept slowly but constantly turning, and no harm will result from withdrawing the creature from the oven and allowing it to collapse, to gain breath or rest; only this relaxation should be very brief. The caterpillar should be first introduced into the oven while inflated by the breath, and so placed that the hinder extremity shall be in the hottest part, directly above the flame, for it is essential that the animal should dry from behind forward; yet not altogether, for as soon as the hinder part has begun to stiffen (which can readily be detected by withholding the breath for a second), the portion next in front should receive partial attention and the caterpillar moved backward and forward, round and round over the flame. During this process any tendency of the caterpillar to assume unnatural positions may be corrected—at least in part—by withdrawing it from the oven and manipulating it; during inflation, the parts about the head should be the last to dry and should be kept over the flame until a rather forcible touch will not cause it to bend.

To secure the best results it is essential that the oven should not be too hot, the flame should not be more than an inch high and its tip should be one or two inches from the bottom of the oven.

When the skin of the caterpillar will yield at no point, it is ready for mounting. The pin is removed from the straw and the caterpillar skin, which often adheres to the straw, must be gently removed with some delicate, blunt instrument or with the finger nail.

A piece of wire a little more than twice the length of the caterpillar is next cut, and, by means of forceps, bent as in Fig. 77, the tips a little incurved; a little shellac* is placed at the distal extremity of the loop, the wire is held by the forceps just beyond this point, so as to prevent the free ends of the wire from spreading, and they are introduced into the empty body of the caterpillar as far as the forceps will allow; holding the loop and gently opening the forceps, the caterpillar is now pushed over the wire with extreme care, until the hinder extremity has passed half-way over the loop and the shellac has smeared the interior sufficiently to hold the caterpillar in place when dry; the extremities of the parted wires should reach nearly to the head. Nothing remains but to curve the doubled end of the wire tightly around a pin with a pair of strong forceps and to place the specimen, properly labelled, in a place where it can dry thoroughly for two or three days before removal to the cabinet.

For more careful preservation and readier handling Mr. Goossens employs a different method, placing each specimen in a glass tube, like the test tube of the chemist. The wire is first bent in the middle and the bent end inserted in a hole bored in the smaller end of a cork of suitable size, so as nearly to pass through it; the loops are then formed as above; both ends of the cork are varnished, and a label pasted around the portion of the cork which enters the tube, thus guarding both specimen and label from dust, and the latter from loss or misplacement. After two or three days the cork with the caterpillar attached is placed in its corresponding tube and the tube may be freely handled.

---

* To prepare this, the sheets of dark shellac should be preferred to the light, and dissolved in forty per cent. alcohol.

Modifications of this system will occur to every one. Dr. Gemminger uses a syringe for the extraction of the contents as well as for the inflation of the emptied skin. For an oven, the Vienna entomologists employ an ordinary gas-chimney open at both ends and inserted in a sand bath, which prevents perhaps the danger of too great heat.

NOTES ON THE CYPRINOIDS OF CENTRAL NEW JERSEY.

BY CHARLES C. ABBOTT, M. D.

THE family of fishes known scientifically as the Cyprinidæ, and popularly as "shiners" and "minnows," is well represented in the Delaware river and its tributaries. A careful study of the several species of cyprinoids found in the immediate vicinity of Trenton, N. J., convinces us how difficult it is to define clearly the distinctive characters of many of these fishes, even with a very large number of specimens to guide us; the tendency to vary in color and fin arrangement being especially noticeable. Therefore, while we have ventured to describe, as new to science, a small cyprinoid, collected by us, for the first time, during the season of 1873, we have purposely confined our notes to the species gathered here in large numbers, and not included in several small collections received from other portions of the state. While, therefore, we propose to give the full list of species, found in but a small fraction of the state's territory, we believe it really presents the entire cyprinoidal fauna of the state.

In his admirable synopsis,* Prof. Cope mentions twelve species, of six genera, belonging to the Delaware and its tributaries. The study of the material at our command enables us to recognize, without difficulty, all of these as described and figured in the synopsis referred to; but there is also, it must be mentioned, many specimens that we have considered as species, as defined by Prof. Cope, in which variations exist, that are of sufficient importance, it would seem, to make them even more than marked varieties—

---

* Synopsis of the Cyprinidæ of Pennsylvania: Transactions of American Philos. Soc., vol. xiii.

varieties that, seen from an evolution standpoint, are well advanced to that point, where the "species" commences and the "variety" ends. To some of these instances, we will call particular attention elsewhere, and remark here that, besides the twelve species given by Cope, there are included four well marked species, of genera not included in the list referred to, being *Hybognathus*[*] Agassiz, *Albernellus* Girard, and *Hyborhynchus* Agassiz, these making the number of genera, nine, that are represented in the Delaware fauna.

So far as our investigations have enabled us to determine, the cyprinoids of the Delaware River, at the head of tide water, and in the neighboring streams, are as follows:—

1. *Semotilus rhotheus* Cope. "Chub." This is our largest and, in the river, our most abundant species. Although the males, in spring, are then most highly colored, they do not become at any season dull or leaden tinted. We have noticed that the variety of tints and general ruddy tinge of the whole fish vary considerably, in different streams; the milky, turbid waters of clay creeks appearing to have the effect of keeping down the rich colors that make this fish so beautiful from March to June, when found in the river or clear spring brooks. Some peculiarities of its coloring fade almost immediately, and others change in hue, on taking the fish from the water. The first published[†] description of this fish, detailed the colors of a living specimen, which accounts, we suppose, for the difference in the general appearance as given by us, and as noticed by Prof. Cope,[‡] when examining dead specimens. The largest specimen we have met with weighed 1 lb. 14 oz.

2. *Semotilus corporalis* (Mitchill). This "chub" is also an inhabitant of several little brooks, sometimes reaching considerable size, but never attaining the dimensions of *S. rhotheus*. As we have often noticed with reference to allied species of fishes, so in this instance; we do not find them *i. e.*, the two species of *Semotilus* associated in small streams, nor intimately so, in the river. Besides the marked difference in color, the smaller scales at once make evident the great difference between this and the preceding; which is much more nearly allied to the northern *Semotilus argenteus* Putnam (*Leucosomus pulchellus* Girard, *et auct.*) "In Gun-

---

[*] Synopsis of fishes of North Carolina: Proc. Amer. Philos. Soc., vol. ii, p. 466.

[†] Proc. Acad. Nat. Sci., Phila., 1861, p. 154. [‡] l. c. p. 564.

ther's Catalogue of Fishes," vol. vii, we find a specimen recorded, of *S. rhotheus*, from the Delaware River; and considered the same as *Semotilus argenteus* Putnam. As the specimen is marked "Adult," it seems strange such an error should have occurred.

3. *Rhinichthys nasutus* (Ayres). Both from the limited number of streams, in which it is found, and from the few individuals which occur, this is preëminently our rarest species.

4. *Rhinichthys atronasus* (Mitchill). "Dace." There are but few streams, except in the northern portion of the state, where this pretty species may be found. Generally, we have met with it, associated with the young *Semotilus corporalis*, and both it and the latter were remarkably successful in escaping from a scoop-net, by *burrowing* under stones, with all the ease of a *Melanura* in the soft mud; or else by leaping several inches from the water, and so passing over the rim of the net.

5. *Stilbe Americana* (Linnè). "Roach." DeKay has described as two generically distinct fishes,* under the names of "Variegated Bream" *Abramis versicolor*, and "New York Shiner" *Stilbe chrysoleucas*, the cyprinoid designated above as *Stilbe Americana*. The two varieties, which are not simply varieties in color, are now conceded to be the same species, and it seems strange that DeKay should have considered these variations of more than specific value, when now it is not accorded even that importance. On studying the descriptions and figures above referred to, and instituting a comparison of these with a very large number of specimens of this fish, we have satisfied ourselves that there exists a well marked tendency to vary in this fish, which verges nearly to that line, beyond which a variety becomes technically a species. DeKay's figure, on plate 29, is an excellent representation of the common "roach," as we find it in quiet waters and the larger streams of this state. Color, which properly goes for but little, in the study of the specific differences of fishes, merits more attention in this case, from the fact that there is not any decided deepening of, or variation in, the tints, in the spring or nuptial dress, as compared with that of autumn or winter. In the case of DeKay's description of *Abramis versicolor*, we have a gaudy species described, which suggests at once a fish taken in early spring, when the cyprinoids, as a class, are in brightest colors; such however is not the case with the *Stilbe Americana*, as when we

---

* Fishes of N. Y., p. 191, pl. 32, fig. 103; p. 204, pl. 29, fig. 91.

examine the figure of *Abramis versicolor*, we find a fish varying in the size and shape of its fins also.

In studying the very large collection of specimens of the "roach," from streams of different character, made during the past summer, we think we have traced a uniform variation in the size and shape of the fins, more especially of the dorsal and ventrals; and with it, a constant difference of the color of the *Stilbes* taken in small, rapidly running streams, and the ordinary "roach" of our mill-ponds and quiet creeks. These differences, in some respects, agree with the distinctions drawn by DeKay between the *Stilbe chrysoleucas* and *Abramis versicolor*, but not in all. Indeed, we have never met with a "roach" that was strictly identical with the fish described by DeKay as a "variegated bream."

The variations we have traced out in a large series, and which we believe to be constant, are as follows:—

Delaware River specimens.	*Shabbaconk Creek specimens.*
Adult, total length,* 7½ in.	Adult (?), total length 5 in.
Dorsal fin, depressed, reaching to the point opposite the 9th ray of anal fin.	Dorsal fin, depressed, reaching to a point opposite the last ray of anal fin.
Ventral fins, depressed, reaching to a point, separated by two scales from the anus.	Ventral fins, depressed, reaching to the anus.
Mouth, when closed, on a line drawn through the pupil.	Mouth more oblique; when closed, the front of the lips on a line with the upper edge of the orbit.
Scales with 7 to 12 radii.	Scales with 4 to 5 radii.
Color as described by DeKay and Storer. Ventral fins crimson on anterior rays, fading into orange. Other fins lemon yellow, with black lines on the dorsal and caudal fins.	Color uniformly blue, with no shade of green or golden; lighter on belly, but scarcely silvery. Fins pale yellow, but at no time crimson or golden.

In order not to mislead the student, it must be clearly understood, that while the specimens of *Stilbe* from the Shabbaconk Creek are uniformly different, as here pointed out, we do find "river" specimens, which are partially grown individuals of the typical *Stilbe Americana*, that in some respects approach closely to the variety characteristic of the Shabbaconk and other clay creeks. But the variations we have described cannot be ascribed simply to age, especially the uniform blue color of clay creek individuals.

---

* In the 4th vol. NATURALIST we have referred to the fact of having gathered many specimens, eight and nine inches long. Compared with the whole number of individuals in any given stream, these measurements are exceptional, and the length above given is about that of the average adult fish.

Do we not here have an instance of adaptation to particular localities; even to the change of color? It has often been asserted that we never see a species undergoing a radical change; but is not this an instance of such change, one possibly now of "specific" value, as a "species" was once considered? The color of the waters, in bulk, is bluish; and it has occurred to us that the blue color of these clay-creek roach may have been created or evolved, for their better protection from our ravenous kingfishers (*Ceryle alcyon*), who swallow them without any preliminary carving, as they are said *not to do*,* in other sections of the country. We have noticed, in fact, that this fish is a favorite prey of the kingfisher; and as each species of fish appears to have its own peculiar odor, when alive, we have thought that this fish was through its odor (and flavor?) attractive to this bird; and when inhabiting shallow streams, and so exposed the more to its attacks, how natural to see, in the changed color, a means of protection as an offset, as it were, to its attractions in odor and flavor.

6. *Hypsilepis cornutus* (Mitchill). "Red-fin." Our "red-fin" appears to be in all respects identical with the New England fish, as figured by Dr. Storer.† Young specimens are much less robust than the figure referred to, but the variations we have noticed, in examining a large series, appear to be all due to age.

Besides the deeper coloring and numerous tubercles upon the snout, the males of this species vary from the females in a stouter body and somewhat more elevated dorsal outline; features which are permanent and uniform.

7. *Hypsilepis analostanus* (Girard). "Silver-fin." This beautiful little fish is a constant companion of the preceding species. A partial study of its habits, by means of the aquarium, has demonstrated, however, that it is a more carnivorous fish, and not only were specimens noticed to tear away the fins of each other and of

---

* NATURALIST for Oct. 1873, p. 634. (Mr. Breed here refers to a note in "Nature" and not the NATURALIST, as printed.)

† Fishes of Mass., p. 118, pl. xxi, fig. 3.

other cyprinoids, but larger ones even killed and devoured adult specimens of *Hybopsis bifrenatus.*

8. *Clinostomus funduloides* Girard. We have, during the past summer, met with single specimens of this last mentioned cyprinoid, associated with other small fishes, on several occasions. They are identical with specimens in the Museum of the Academy of Sciences, at Philadelphia; marked by Prof. Cope, from tributaries of the Susquehanna River, Penn.

9. *Hybopsis bifrenatus* Cope. "Minnow." This little fish, characterized by an imperfect lateral line, and deep straw color and black markings, is probably our most abundant species of this genus.

10. *Hybopsis chalybœus* Cope. "Minnow." This species, which much resembles the preceding, has a complete lateral line. It is not uncommon, and usually met with, associated with the other small *Hybopses.*

11. *Hybopsis procne* Cope. "Minnow." To quote Prof. Cope, "This small species may be readily distinguished among others common in our streams, by its long caudal peduncle and tail, its large brown-edged dorsal scales and plumbeous lateral band."

The first mentioned of these three species of *Hybopsis* is everywhere, in New Jersey, exceedingly abundant, and supplies the carnivorous fishes with an unfailing supply of food. In a collection of *Hybopses* before us, we find the three species represented in the following proportion, and believe this to be about their relative abundance in the Delaware and tributaries, at this point.

Whole number of specimens, 123.

Of *H. bifrenatus*, ...	75	specimens.
" " *chalabœus*, ...	22	"
" " *procne*, ...	26	"

In identifying the above series of small minnows, we have been guided solely by Cope's synopsis, to which we have so frequently referred. While we believe we are correct in our identifications of the three species, we must here mention that there were some individuals of this series (and it holds good of every collection we have made, of small *Hybopses*) which we found it difficult to determine, as to their specific relations, that were in fact neither *bifrenatus* nor *chalybœus*, and, as we believe, not the young of other fishes. In a series of a thousand individuals, one will be pretty sure of finding intermediate forms, which link these three *Hybopses* very closely. This presence of intermediate forms is not confined, however, to these small minnows. In every large collection of cyprinoids we have yet made, there occurred some individuals, that varied in one or more directions from typical forms, and yet not in such a manner as to indicate probably permanent specific or generic peculiarities.

12. *Hybopsis Hudsonius* (Clinton). "Spawn eater." This interesting cyprinoid is exceedingly abundant in the several tributaries of the Delaware River. The several published figures of the species are characteristic; both those of DeWitt Clinton,[*] who first described this fish, and that given by DeKay,[†] are quite accurate, and give the best representations of it we have seen. Prof. Cope's[‡] figure of "*Hybopsis Hudsonius*" we believe to be that of the following species, as will appear. At all events, it is a much more marked variety of the true *Hudsonius*, than the small blue *Stilbe* we have described is of the typical *S. Americana*. Of the true *H. Hudsonius*, DeKay writes: "It is called "spawn-eater," from an idea entertained by fishermen that it lives exclusively on the spawn of other fishes." This belief has no doubt arisen from the fact of its having a "sucker"-like habit of feeling carefully over the bottom of the stream with its peculiar "telescopic" mouth extended, and so sucking up such food as it finds to its liking. The examination of the stomachs of many specimens shows that, like the *Stilbe Americana*, it feeds very largely on small mollusca, that cover every stone and other stationary object in the beds of our streams. We do not think the charge of spawn-eating can be laid to this fish with more reason than to all the other cyprinoids. Indeed, without an exception, the ova of all other fishes are, to every species of fish, a luscious morsel; and we are inclined to think that many fish are so far *unnatural* (?) as to devour the newly-laid ova of their own kind.

The very blunt snout, almost at right angles with the forehead, gives this fish an abrupt profile, which, especially when living fish are compared, is a ready method of distinguishing this species from the closely allied *Hybopsis phaënna* Cope, with its more tapered, regular profile.

---

[*] Annals Lyceum of Nat. History of N. Y. Vol. 1, p. 49, pl. 2, fig. 2.

[†] Fishes of New York, p. 205, pl. xxxiv, fig. 109.

[‡] Synopsis of Cyprinidæ of Penn. Pl. xii, fig. 3. (Trans. Am. Phil. Soc., Vol. 12.)

13. *Hybopsis phaënna* Cope. Prof. Cope* has described the cyprinoid here referred to as a distinct form of *Hybopsis*, having received specimens, collected by the writer, in 1864. He says, "*Hybopsis phaënna* is a species, found in some of the tributaries of the Delaware, which I have received from Trenton, N. J., from my friend Charles C. Abbott. It is more elongate in form than *H. Hudsonius* and *H. Storerianus*, and has not the rounded front of the first or small compressed head of the last. Eye a little less than one-third length of head; latter $5\frac{1}{3}$ times to concavity of tail, and more than equal greatest depth of body. . . . . . Angle of mouth not posterior to anterior nostril. Scales $\frac{5}{4}$, 38. Lateral line very slightly deflected opposite the dorsal fin. Base of caudal to posterior edge of dorsal, equal from latter to beginning of the skin of the head. D. 1–8; C. 19; V. 1–8; B. 1–9; P. 15; Length 4 inches."

The differences between the two, *H. Hudsonius* and *H. phaënna*, which are quite uniform and readily noticed in living specimens, are as follows:

Hybopsis Hudsonius.	*Hybopsis phaënna.*
Snout blunt. Angular in profile.	Snout tapering. Curved in profile.
Diameter of orbit less than length of snout.	Diameter of orbit more than length of snout.
Anal fin, depressed, reaches to the anus.	Ventral fin, depressed, does not reach the anus.
Bright silvery stripe along the lateral line, golden posteriorly, and uniform olive-green from dorsal stripe to lateral line.	Plumbeous stripe along the lateral line; and four narrow blue lines between the dorsal stripe and lateral line.

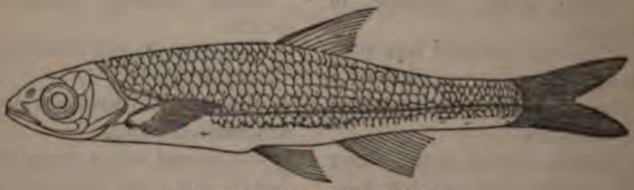
Prof. Cope, in his monograph of Pennsylvania cyprinoids, says "There may still be some question as to the pertinence of this specimen (from the Delaware, at Trenton, N. J.) to *H. Hudsonius*," he having referred it to that species then, and subsequently. Were there no specimens of the cyprinoid found in the Delaware that were precisely such as described by De Witt Clinton, then it might be thought that the *H. phaënna* was simply a modified form of that species; but the two being associated, each preserving the distinctive features, as pointed out by us, with the non-occurrence of individuals, that by less pronounced features link the two, leaves little ground for doubting their being really, specifically distinct. It should be remembered, also, that the *H. phaënna* reaches a larger size than the *H. Hudsonius*, here in the Delaware, and the "more conic form" of the snout cannot be ascribed to maturer age, as has been done by Prof. Cope. Specimens three and four inches long are in every respect like Clinton's figure of *H. Hudsonius*, while specimens of *phaënna*, five and five and a half inches long, have the tapering profile, much as in the drawing given by Prof. Cope, and above referred to. In conclusion, we must add that, in the figure given by Clinton, the circular black spot at the base of the caudal is a very marked feature. Cope says in his description, "no spot at base of tail." Now we believe the truth to be, that the *H. phaënna* is also to be recognized by the absence of the caudal spot, which we have never failed to note on typical specimens of the *H. Hudsonius*.

---

* Proc. Acad. Nat. Sci. Philad. 1864, p. 279.

14. *Alburnellus amœnus* Abbott. The discovery of this beautiful cyprinoid makes the second instance of a genus being represented in the Delaware and Ohio rivers, and not in the intermediate river system of the Susquehanna. It was first met with, by the writer, in the summit level of the Delaware and Raritan canal, associated with *Hybopsis Hudsonius*, *H. phaënna*, *Hypsilepis analostanus* and *Hy. cornutus*.

Fig. 78.



Alburnus amœnus. Natural size.

We give the following description of the species with a figure* (Fig. 78). Head shorter and broader than Alburnelli generally; with the profile less pointed anteriorly to the orbit. Orbit large, equal to length of the muzzle, and entering length of head 3·25 times; but a trace less than the interorbital space. Head 4·25 times in length to basis of caudal; greatest depth, four and two-thirds (4⅔) times to same.

---

* The figure was engraved without correction of the drawing on the block and is not accurate in its details.—Eds.

Pharyngeal teeth 1,4—4,1; moderately hooked, and with a narrow masticatory surface, more noticeable on one specimen examined than on the other. The single tooth of the series is in all respects similar to the others, but only half the size. Occasionally the series is 2,4—4,2, as in *Alburnellus rubrifrons* Cope. Anterior ray of dorsal slightly posterior to the insertion of the last rays of ventrals. The anterior ray equals in length the posterior margin (terminal) of the fin. Terminal ray slightly in advance of the anterior ray of anal fin. Anal fin broad, the base equalling the length of the anterior ray. Terminal margin of the fin slightly concave in outline. The pectoral fins terminate at a distance of three scales' width from the insertion of the ventrals. Terminal margin of the ventrals opposite fifth ray of the dorsal.

Lateral line decurved from the upper angle of the opercular apparatus, and continues in a slightly oblique direction to some distance beyond the dorsal fin, and *not rising again opposite that fin and continuing straight to the caudal fin*, as in *Alburnus rubellus* Agassiz. D. 1–8; A. 1–11. Scales 5–39–3. Total length, 3½ inches. Color, pale olive above, with minute black dots on the exposed edges of the scales. A bright silvery band three scales wide at the operculum, and narrowing to a width of one and one-half scales at the base of the caudal fin. Operculum and iris pure silvery. Belly white, but not with a metallic gloss.

The specimens taken were collected late in August, and the colors noted while they were in an aquarium. At present they are rare, both in the river and its several tributaries, and we are confident that we have never seen them previous to last summer, although accustomed carefully to collect and study our various small fishes for the past dozen years; and from the fact of finding it only in the canal, which has an unobstructed outlet into the Raritan River, 25 miles east of the Delaware, it may be that the fish in question is properly a species belonging to that river. It was in this stream that the following species was first met with, in 1870; and now, as will appear, it is a very abundant species in some of the Delaware tributaries; probably derived from the Raritan River, through the communication opened by the canal referred to.

15. *Hybognathus osmerinus* Cope. This very interesting species was discovered by the writer, associated with our common smelt or "frost fish" (*Osmerus viridescens* Mitchill) from the Raritan River, at New Brunswick, N. J. It was first described by Prof.

Cope,* from a specimen we sent him, and has since been figured by the writer.† During the interval, from the time of first detecting this peculiar species until the present summer, we have never met with even a single specimen; the few small fishes supposed to be this species, and referred to by us, in the 4th vol. of the NATURALIST, proving to have been young of other fish, and had we properly studied at the time the anatomy, instead of relying upon the external appearances, such an error would not have occurred. The statement *then* made, however, is *now* correct; for the abundance of this species in some localities is very remarkable.

During the present summer, Prof. A. C. Apgar and the writer fished, with a large seine made of mosquito netting, a pond formed by the united waters of a large spring and the inflowing current of the Delaware and Raritan Canal. To our surprise we found the cyprinoidal fauna to consist wholly of this species, associated with the "roach" and the three small "minnows," *Hybopses.* We procured over one hundred specimens, and from them note the following with respect to their size and appearance. The adult size is probably five inches; the largest specimen taken by us measuring within a small fraction of that length. The orbit, which, both in the drawing given by us, as above referred to, and in that given by Girard of *H. argyritis*, in the tenth vol. Pacific R. R. Survey, is oval, is in the adult living fish, nearly, if not quite circular, and less oval in the young living fish, than represented. After long immersion in spirits, we notice that the eye is oval, rather than circular. Otherwise, externally, we note no variation from Prof. Cope's description. It is given, by Prof. Cope, that the length of the intestinal canal, which is a generic character, is, in *Hybognathus*, four times the length of the fish. On careful measurement of the intestines, in over fifty dissections, we find the length, in *Hybognathus osmerinus*, *to vary with age*, and that it is never less than five and one-quarter times the total length. This is a considerable difference, even in fish measuring only three inches in length. Unlike the fourteen other cyprinoids found in the same streams, the peritoneum in this species is uniformly and intensely black. Examination of the contents of the intestines showed an exclusively vegetable diet, which was indicated by the peculiar character of the pharyngeal teeth — without hooks and cultriform — and length of the intestinal canal; it being, as a rule, longer than the total length of the fish, sometimes many times longer, in the herbivorous; and as long, or less than twice as long, in the carnivorous and omnivorous species.

---

* Proc. Amer. Phil. Soc., vol. 11, p. 466 (foot note).

† AMER. NATURALIST, vol. 4, p. 717.

The preferred haunts of this cyprinoid are still waters, with muddy and weed-grown banks and bottom. If undisturbed it lies quietly in the growth along the banks, or in the bed of the stream, and only leaves its hiding place when frightened. It is a sluggish fish, compared with some species, but in the aquarium is active enough, to make it desirable.

16. *Hyborhynchus notatus* (Rafinesque). Among the many hundreds of specimens of our cyprinoids, gathered during the present summer, occurred one solitary individual, that in the aquarium was particularly noticeable for his very blunt snout, small, *inferior* mouth, and the fact of the osseus dorsal ray being separated from the adjoining ray by a membrane. These facts indicated its genus as *Hyborhynchus;* and the length of the alimentary canal, and character of the pharyngeal teeth, showed, on dissection, that the external characters had not been misinterpreted. On careful comparison of this single specimen with Gunther's description* and the figure given by Prof. Cope,† we find that it agrees very nearly with the *Hybor. notatus*, from northern and western rivers. The only differences we could detect were a somewhat larger eye, possibly a more tapering snout, and no trace of a black spot at the base of the tail. Experience in the study of this family of fishes shows that these may all be merely individual differences.

The specimen taken was captured, associated with the foregoing *Hybognathus*, and was placed in the aquarium as such; but the differences were very noticeable when the two species were seen together moving slowly about the plants in the tanks and nibbling at the foliage with their peculiar mouths.

Having completed the list of our cyprinoids, we will, in conclusion, give it a moment's consideration from an evolution standpoint. With no faith in the immutability of specific or generic forms, it at once occurs to us that the list might be properly curtailed by considering as merely "varieties," the *Hybopsis phaënna*, *i. e.*, a variety of *H. Hudsonius;* that possibly the three small

---

* Catalogue of Fishes, vol. vii, p. 182.

† Penn. Cyprinidæ, pl. xiii, fig. 5.

Hybopses are not as widely different as supposed; and that the *Hybognathus osmerinus* is, in truth, not "specifically" distinct from the allied *argyritis;* that, in fact, it would be more consistent to consider these all, as we did the small blue *Stilbe* of our clay creeks.

If, by a "species," we meant anything other than a convenient arrangement of the various forms of animal life for purposes of study, or saw in the "species" of cyprinoids anything but so many varied forms which natural selection has evolved from some primitive form of omnivorous fresh-water fish, that has given rise to a variety of forms, through a long series of generations, that would, each in its own place and time, suit the particular haunts it chanced to frequent or was forced to occupy; if we have any other thought in view, then, it would be grossly inconsistent to add to the long list of so-called "species." We do not, however, consider "species" otherwise than as here sketched out, and considering also the amount of variation among any considerable number of individuals of any one "species," and believing that varieties are steadily though slowly becoming more and more varied, and so gradually entering what may be termed "specific territory," we claim that no undue use of the imagination will be brought into play, in recalling a primitive, typical cyprinoid, when we range, side by side, adult and young specimens of each of even the sixteen "species," that we have met with so far, in the Delaware River and its tributaries, in central New Jersey.

THE MIGRATION OF BIRDS.

BY T. MARTIN TRIPPE.

THERE is nothing connected with the fascinating study of ornithology that possesses a greater attraction than the migrations of birds. There is so much of the mysterious in their coming and going and we know so little of the manner in which their journeys are performed, that our very ignorance lends an additional charm to the mysterious interest involved. Anemones and buttercups spring up in a day, where yesterday they were not; but ere they come, we might have found the sprouting blades and tender buds that promised future blossoms as soon as the warm April rains should fall. Like the flowers, the birds come to us suddenly and almost unawares; a day ago there were none; to-day, the woods and fields are vocal with their music; but, unlike the flowers, there was no herald to announce their approach, no presage of their coming. Ere we are aware they are with us; before we know it, they are gone.

On some bright February morning, I go out into brown sere meadows, and wander along the banks of a brook, covered here and there with dense thickets of tall alders and hornbeams, with an undergrowth of blackberries and greenbriars. Yesterday, the only inhabitants they contained were tree-sparrows; to-day they hold a party of red-winged blackbirds, whose harsh merry notes and jolly chatter proclaim their joy at being home again. They have come, perhaps, from reedy marshes that line the Virginia coast; or, perchance, from Carolina rice-fields; but no man saw them on their journey; silently and unannounced, they came and reoccupied their summer haunts. A little later, I visit the same wet meadows, and find them frozen at the depth of a few inches, though on the surface, the black soil is soft and muddy; then comes a heavy rainstorm the next day, and on the succeeding morning, they are alive with snipe. Or, some morning in May, when the woods are beginning to unfold their green robes and the towhee to call from the thickets, I find, here and there, a warbler or two; but only one or two, save, now and then a troop of coronatas. A storm from the south sets in and lasts for a day or two; and when it has ceased, in the morning, I go out into the woods again; and hundreds and thousands of warblers of a dozen species are fluttering through the boughs and copses, and lisping in the tree-tops. How they came, I know not, nor whence; but here they are, where, a day ago, scarce one was to be seen. Two days more and nine-tenths of them are gone.

There are some birds whose migrations are apparent enough. In November we see flocks of robins passing south, high up in the air, calling to each other as they go. In March, and again, late in fall, long trains of crows silently stream across the sky; in September flocks of red-birds wing their way overhead, their presence betrayed by their mellow notes. The ducks, geese and cranes, with much noise and gabble, announce their passage through the country; and in the later days of autumn, the hawks, distant specks against the sky, are seen floating slowly southward after their departing prey. But the vast majority of birds come and go silently and unawares. No one sees the wren or the sparrow on its migration; no one knows how long they are on the way, or by what route they reach their destination. We know that they come from the south in the spring and return in the fall, and there our knowledge ends.

Most birds move north and south in their migrations; but although this is the general direction of the movement, it is affected more or less by various circumstances. On the seaboard, it follows the general course of the coast, and in the west it is influenced by the border line between the prairies and the forests which, throughout Minnesota and Wisconsin, lies in a northwest and southeast course. Mountain ranges and the interior lakes alter the general north and south direction more or less, and the isothermal lines point out other variations. Some birds appear to follow different routes on the autumnal migration from that which they take on the vernal. The Connecticut warbler, a not uncommon bird in northern New Jersey during fall, is exceedingly rare in spring; while, on the other hand, the Blackburnian warbler is far more abundant in spring than in fall. Other species, again, appear to take a fancy to some particular line of flight, and adhere to it for a number of years, then deserting it for some other. I have known the golden plover, for instance, to be quite abundant in certain localities, for two or three years; and then to disappear almost entirely for a long period. The greater number of vast flocks of wild fowl that sweep up the Mississippi valley every spring, on arriving at the mouth of the Minnesota, sometimes follow up one valley and sometimes the other; one of the two invariably attracting by far the larger proportion, though without any apparent reason.

The regularity which marks the arrival and departure of some birds is quite remarkable. For five successive years, I noticed the first coming of the crow and red-winged blackbirds on the 22nd of February, and so punctual were they, that at last I came to expect them almost as certainly on that day, as though they had been a company of players, announced to appear at a certain time and place. If the weather was unusually stormy or the reverse, their arrival was a day or two later or earlier. Between the 14th and 19th of October, I expected to see the southward flight of the crows; and very rarely did I fail to notice it within those dates. But other species show the very reverse of this regularity. The snipe and the ducks are notoriously uncertain in their movements, in some seasons coming weeks earlier than in others. The bluebird may be seen, in some years, every winter month; and in others, not one may be found till late in February. The bluebird, however, is a homesick little fellow away from his native orchards, and two or three fine warm days are apt to lure him back, even in the middle of January.

That many birds return, year after year, to the same localities is well established; but it may be doubted if this is the case with all, or even the majority. Spallanyane's experiment is well known; he tied bits of red silk to the legs of several swallows that haunted the house in which he dwelt; and spring after spring, observed the same birds return to their native place. A pair of bluebirds that had taken up their abode in a little bird-house, put up for their especial benefit, returned for several seasons to the same favorite nesting-place—at least I always fancied that I could recognize the same pair—and, as if to obtain undisputed possession of their snug quarters, invariably appeared a few days in advance of the other bluebirds. A pair of night herons took up their residence for three successive seasons, in a little, secluded swamp, where neither before or subsequently, for several years, were they ever seen. Similar instances doubtless occur to every ornithologist.

Of many species the males and females travel together; of some, the former precede the latter; but I know of none where the females migrate in advance of their mates. The robin is a familiar instance of the first case; and probably all the thrushes follow his example. The bluebird, in spring, almost always travels in pairs, except very early in the season when a solitary male sometimes appears. With the *Fringillidæ*, or most of the species, at least, the sexes migrate together. The redstart and some of the warblers appear a little before their less gayly-colored mates; and I suspect that this is the case with nearly all the *Sylvicolidæ*. The bobolink is a conspicuous example of the same nature; on the prairies of Iowa, flocks of hundreds of males may be seen, several days before a single female arrives. The rose-breasted grosbeak is still another instance, and many others might be mentioned. As a general rule when the males are brighter colored than the females, the former precede the latter; and when there is little or no difference between the plumage of the sexes, both travel together either in flocks or in pairs. In the autumnal migration this distinction is obliterated, and nearly all birds associate together in small parties or large flocks, composed of both sexes; and with many the females and young retire southward, a little in advance of the hardier, adult males.

Few birds are absolutely stationary. Even those that we see throughout the year are migrating to a greater or less extent. The robins that we meet with in midwinter have descended from higher latitudes, while those that passed the summer with us have gone to warmer regions. Specimens of the same species, taken in winter, differ from those of summer in being larger and stouter. The earliest birds that reach any given locality in spring are usually brighter colored and larger than those that breed there, the former passing farther north as the latter arrive. Most birds begin nesting immediately after arriving at their destination, and when, as is the case with the robin, the first comers appear weeks in advance of the breeding season, they remain but a short time, moving slowly northward until they have reached their homes when they at once commence the task of raising their young, shortly after which they begin retiring to the southward. There is thus a constant movement going on, interrupted only by the brief breeding seasons; a general swaying north and south in which one limit is scarcely reached, before a retrogression sets in towards the other; and when, as is frequently the case, the southern limit of the northernmost representatives of a species, is north of the summer range of the southern races, the species is looked upon as resident, although the individuals composing it are strictly migratory. This is the view of J. A. Alllen, as set forth in his interesting "Notes on the Birds of Iowa," and, I believe, corresponds with those of nearly all writers on the subject; but high authorities disagree. Audubon states that the snipe, *Gallinago Wilsonii*, does not appear in Canada and Maine, until nearly three weeks after it arrives on the marshes of New Jersey; while Frank Forester, whose observations in this case are quite as reliable, asserts positively that the snipe appears nearly simultaneously in northern New Jersey, and along the St. Lawrence River as far down as Quebec. The subject has been little studied, and promises most interesting results to a careful investigation; the lack of data however, is an almost insurmountable difficulty to be encountered at the very outset.

Yet some species remain in the same localities throughout the year. The gallinaceous birds are true residents of the regions in which they raise their young; and many of the *Corvidæ* shift their quarters very slightly, if at all, in any season. Some of the rapacious birds, especially among the owls, are quite stationary; and among the woodpeckers, are species that appear to reside constantly in the same localities. Other species, again, seem to be indifferently migratory or stationary. Of the vast numbers of mallards that frequent the ponds and streams of Texas, during winter, great numbers are said to remain and breed, while the others rove hundreds of miles to the northward.

In the "Natural History of the state of New York"* DeKay gives the Carolina titmouse as being found in southern New York in winter only. If this observation is correct, it affords a unique instance of a bird migrating north in winter; but there is good reason to doubt the accuracy of the statement.

The causes of migration are various; but the principal one is undoubtedly the want of food. Birds seek a milder climate than that of their native regions, because their means of subsistence fail, and they must either obtain it elsewhere, or starve. As soon as the chill of autumn destroys the greater number of insects, and banishes the remainder to their winter retreats, the insectivorous tribes are compelled to migrate to regions where a warmer sun sustains a sufficiency of insect life to supply them with food; and the granivorous species, finding their usual stores of seeds either becoming exhausted or covered with deep snow, follow in their track, while rapacious birds are obliged to accompany their prey. Only the species whose food-supply is unaffected by the inclemency of the season remain. The nuthatch and brown creeper are able to find as ample fare in one season, as in another, and a few sparrows find sufficient food in such scattered weeds as appear above the snow, or amid sheltered nooks and thickets protected from the storm. Even in the coldest weather, wherever the cedar berries are abundant, we find robins, who refuse to leave as long as they can find anything to eat; and bluebirds may be seen amid clumps of sumachs, clinging to their northern homes, until compelled to go by absolute necessity. In wet, springy meadows, and in grass fields, in the eastern states, the meadow lark finds a sufficient supply of food to subsist upon throughout the winter; while on the western prairies, under a less degree of cold he migrates as regularly as the kingbird, being unable to procure the requisite supply of food in his summer habitat. The snipe and the woodcock linger as long as they can find unfrozen marshes and swamps; and in mild seasons, may be found about warm, springy meadows and coppices, sheltered from the frost, even in mid-winter. But were it possible for them to find a sufficiency of worms, and could the warblers obtain such insects as they habitually feed upon, the woods and marshes, instead of being nearly deserted for several months, would remain tenanted throughout the year. Just as soon as the rigor of winter has passed away, and the changed temperature calls forth myriads of gnats and flies to swarm in the woods, and the frozen earth thaws, and permits the worms to approach the surface again, they come back to their native regions from which they had been temporarily driven by stern necessity.

---

* Possibly, I am mistaken in the reference. If so, the statement is made in Giraud's "Birds of Long Island."

The supply of food, however, is so closely governed by the seasons, that the migrations may be said to depend upon them, although, absolutely speaking, the paramount necessity of subsistence, and not the mere effect of heat and cold upon the birds themselves, is the main cause. Hence, we find, as a rule, that the migrations of those birds, whose food is most affected by a change of temperature, are more regular and extended than those of other species, whose subsistence is more independent of the seasons. The Colopteridæ, Sylvicolidæ, and all insectivorous birds that capture their prey upon the wing, belong to the former class; their range extends, in most cases, many hundred miles north and south, and the migration is complete, few or no individuals lingering behind the rest in their summer abodes. The granivorous species on the other hand, living principally upon seeds, are more stationary, some of them finding a sufficient supply of food in their native haunts, throughout the winter, while the rest migrate southward, though they seldom go as far as the insectivorous birds. The omnivorous species are still more independent; some of them, as the raven, are strictly non-migratory.

Nevertheless, in some cases, mere temperature, unconnected with the question of subsistence, seems to be the motive in moving from one region to another. There is no apparent reason why the pine grosbeak should not find as abundant a supply of food in the northern forests during cold winters as in mild; yet it is only during the former that it descends to the latitude of New York; while in the latter it does not migrate as far south by one hundred and fifty or two hundred miles. The pine finch, and the crossbills are similar instances. On the other hand, a long, hot summer is apt to entice some southern birds farther north than usual.

Man exercises a very considerable influence upon the migration of some birds. The clearing away of forests, and the planting of trees upon the prairies, attract species that formerly could not find the means of support in those regions; and compel others to shun localities which they were wont to frequent. Fifty or sixty years ago, according to Audubon, the mallard and the wild goose, as well as some other species of water-fowl, bred in considerable numbers in the Mississippi valley; but as the settlement of the country progressed, they retreated farther and farther north, until at the present day, very few raise their young east of the Missouri and Red rivers, or south of the British boundary, although some still nest in central and western Minnesota, and northern Iowa. In this case the necessity of reaching a secure, safe retreat, remote from the settlements, has caused them to extend their migration far beyond its former limit. Doubtless a similar motive has acted in other instances with similar results. The desire to rear their young in quiet and seclusion, is a very strong one in many birds; and if disturbed or annoyed in any way, they will soon abandon the region, and seek another where they can pass the breeding season unmolested.

Violent storms, and sudden changes in the weather, are often preceded by, or accompanied with, extraordinary migration among birds. The immense flocks of pigeons and blackbirds that occasionally pass through the country are familiar to every one. Several years ago I witnessed an unusual migration of the latter bird, which I have never seen equalled, either before or since not even in the coast marshes where they sometimes congregate in enormous flocks. The latter part of February, and first week of March had been very mild and warm, and great numbers of crows, redwinged and cow blackbirds had gone north. There came a sudden, violent storm from the north one night, accompanied by showers of hail, snow and sleet, continuing all next day, and driving before it, immense multitudes of blackbirds. Vast flocks, flying close to the ground to escape the fury of the blast, passed by so continuously that it was often impossible to tell where one ended and the next began. For four or five hours the immense hosts kept sweeping by; the air at times seemed filled with them; and I was vividly reminded of Audubon's account of the wild pigeons in Kentucky. The storm expended its fury within a few hours after the last blackbird had passed; but although the next few days were clear and warm, not a bird reappeared for nearly a week. A similar migration of white-bellied swallows took place near Newark, New Jersey, some six or seven years since, in the latter part of October, just before a long, northeast rainstorm, followed by sharp frosts. Although their numbers were not equal to those of the blackbirds, the sky at times, seemed fairly covered with their hosts, tens of thousands being in sight at any moment for nearly an hour. Their course was to the southwest; and as if aware of the impending storm, their flight was hurried and direct, far different from their usual circling, easy motion.

But the most remarkable instance of the kind that ever came across my observation occurred in southern Iowa, in the fall of 1871. The weather, at the time, was the perfection of Indian summer,—clear, bright and warm. About the tenth of November, vast numbers of cranes began to fly south. Always a common bird in spring and fall, they appeared in such multitudes, that settlers, who had been in the country for twenty years or more, declared they had never seen anything to equal it. Thousands upon thousands covered the sky at all hours of the day, floating in slow easy circles, far up in the air all moving steadily southward. Most of them were of the sandhill species; but here and there, sweeping in wider circles far above their brown brethren as if conscious of their superior beauty, a flock of white ones appeared,—a beautiful sight, their snowy plumage and black quills sharply outlined against the blue sky; sometimes so high up that they looked like mere white specks, and their loud rattling cries sounded like faint echoes of the whoops of those far beneath them. For three days the remarkable procession lasted; then for the next two days, although the weather continued as warm and clear as it had previously been, not a crane was to be seen; and after that, without the slightest warning, a succession of violent snow, hail and rainstorms set in, followed by intense cold. On the 18th of November the mercury sunk to 5° F., and by the 22nd there was ice upon the ponds, five inches in thickness. The cranes had not escaped a day too soon.

Many birds prefer to migrate during peculiar conditions of weather. The crows almost always move north against a high March wind. A long rainstorm with heavy winds, in the early part of May, is almost sure to be followed, as soon as it has cleared away, by a great influx of warblers; and I have noticed that the migrating hawks often appear in much greater numbers than usual under the same circumstances. In May, 1865, a long northeast storm, clearing up in the evening of the second day, was followed by an extraordinary flight of hawks. Spending the day in the woods, I was astonished at the number, both of individuals and species. They passed overhead, just above the tree-tops, every moment; sometimes singly, sometimes in pairs, and at times in small parties of five or ten or even twenty or thirty. At a low estimation, I saw a thousand during the morning; and have no doubt that I might have seen ten times as many had I been in the open fields, instead of dense woods. The red-tailed, sharp-shinned, Cooper's and broad-winged species were the most common; but half a dozen other species were observed, including a golden eagle, the only one I ever saw in that locality. All were pursuing the same course—northeast—and all flew at nearly the same elevation, close to the tops of the trees, as if to avoid the strong head-wind as much as possible. Although I had nothing larger than No. 10 with me, such alluring shots were constantly presenting themselves, that I was tempted to fire a score of times or more, without loosening a feather. Had I been supplied with the proper ammunition, I might have secured fifty specimens that day. Other instances are afforded by the hummingbird, who journeys only on the brightest, sunniest days; and the snow bunting, whose predilection for travelling with snow storms, has gained for him, among the Swedes, the name of "bad-weather bird."

But although we may assign many reasons for the migration of birds, there is much about them that is seemingly inexplicable.

It is hard to say, for instance, why the black-throated bunting should delay his coming till May, when his relative, the chipping sparrow arrives a month earlier, and the song sparrow a month or six weeks earlier still; although neither is equipped with stouter bills or forms, or are apparently better adapted to withstand the cold. Or it would be puzzling to tell why Aiken's snowbird, which remains all winter in certain portions of Colorado finding abundant food, should migrate in spring, while a closely allied species, or variety, the chestnut-backed snowbird, appears just as the former is leaving, and occupies its place. That an insectivorous bird, as the wood pewee, for example, should delay its coming for a month or more after its cousin the phœbe, is explicable by the supposition that the two birds prefer different varieties of insects, and migrate only when they are to be found; but in the case of the granivorous birds, such an explanation is not admissible. It may, perhaps, be merely the force of habit; and such a theory is borne out by the fact that at distant points on the same isothermal lines, the different species do not, by any means, preserve the same order of coming. The water thrush and the towhee arrive two weeks earlier in central Iowa, than they do in northern New Jersey; the yellow-crowned warbler and two or three others on the other hand, are several days later; while most of the birds appear about the same time. But however that may be, whether future migrations will fully and completely reveal all the causes which influence the migrations of birds; or whether many of them are such as to baffle our researches, the subject loses none of its interest because we do not at present fully comprehend it, and must ever remain one of the most engaging studies in natural history.

ON THE STRUCTURE AND CASTING OF THE ANTLERS OF DEER.

BY JOHN DEAN CATON, LL. D.

My investigations of the structure, system of nutriment, mode of growth, cause of death and rejection of the antlers of the *Cervidæ* have led to results which may interest the readers of the NATURALIST.

Notwithstanding Buffon insisted that the deer's antlers were vegetable products, like shrubs, grown upon the animal body, comparative anatomy has long since recognized the fact that they are bone. They are composed of the same constituents as other bones, but with a larger proportion of animal tissue, and as we shall presently see they are organized in the same way. They are anomalous bones, no doubt, and they differ in their economy from ordinary bone just so far and no farther, than these peculiarities require. They differ from all other bones in being entirely superficial. They are of very rapid growth, speedily mature, die and are soon thrown off, while all other bones are of very slow growth and persistent with the animal through life.

Like all other bones, for their growth and sustenance, they are provided with a *periosteum* with *Haversian canals* and *systems* and *medullary arteries*.

These external bones are grown upon a permanent process of the skull called *pedicels*. The periosteum of the antler, during its growth, together with a black cuticle covering it in which a coat of fine fur is inserted, is called the *velvet*. In this are a great multitude of large arteries which everywhere give off branches, which penetrate the growing antler and convey the blood to the Haversian canals, which are surrounded by, and connected with, Haversian systems, the same as in the long internal bones.

Besides this supply of nutriment from without an internal supply is provided for in two ways. First, a main artery, with a multitude of auxiliaries, passes up through the pedicel into the antler, which answers well to the medullary artery, and secondly a number of large arteries branch off from those of the periosteum at the end of the pedicel, and pass in through the articulation where the transitory unites with the permanent bone. These also pass up into the new-growing antler. Let any one take the first deer's head with horns which he finds in the market, and dissect away the skin at the butt of the antlers, and he will see with the naked eye the canals for these arteries passing into the articulation. The veins are mostly internal.

Thus understanding the system of blood-vessels provided for this external bone, and remembering that the blood-vessels are required to be, as they are, vastly larger than for internal bones, we are now prepared to follow its growth from the beginning to the end.

When the dead antler is cast off, which generally occurs with all but one of our American species in early winter, the blood-vessels of the periosteum reaching the butt of the antler are ruptured and a tolerably copious flow of blood from them ensues. They immediately set to work and extend the periosteum over the end of the pedicel, filling up the concavity in the top of the pedicel, constituting the seat of the new antler. It remains in this condition till spring arrives, when intense activity is observed in this covering, the temperature of which is greatly increased, and it becomes exceedingly sensitive like any other inflamed part. It is now observed to rise up appearing like a large blood blister, and the rudiments of the fur on the cuticle are observed. It rises up rapidly, forming within itself new systems of blood-vessels till it has attained a height of about twice its diameter, when an osseous deposit is commenced at the circumference of the top of the pedicel. Thus, is commenced the wall of the new antler which is now built up rapidly by new deposits, maintaining about the same distance from the upper end of the column, and very nearly of the full diameter of the perfected antler. As the wall rises it thickens very slowly, the upper extremity presenting a thin serrated edge. At first, the deposit presents the appearance of cancellated tissue, which is first filled up at the circumference and gradually resolved into Haversian canals and systems, which are supplied from the periosteum as before stated. If now we examine a specimen in its full career of new growth, say eight inches long, and one inch in diameter, we shall find the upper two inches a mass of highly inflamed blood-vessels, very sensitive to the touch, while below we can feel the established walls when the periosteum has become quite insensible. Let us dissect it and we find the cavity, large at the upper extremity, gradually narrowing to the lower end of the antler where it may be less than a quarter of an inch in diameter, but this opening does not terminate with the antler. It passes down into the pedicel where it may be a sixteenth of an inch in diameter, constituting the canal for the medullary artery. The whole internal portion of the pedicel is porous, admitting the passage of the other vessels through it into the growing antler above, passing through the cancellated tissue which has formed above till they reach the cavity where they unite with the vascular system, continually forming, as the new growth is extended upward. When a tine is to be thrown off, the beam widens and flattens and the member grows out from the shell, and thus the growth goes on, each progressing, in a proper ratio, so that the tip of each tine and snag is completed about the same time. By this time also the whole interior of the antler is filled with the cancellated tissue, solidified to a good degree towards the surface. The extremities are first completely solidified. Now occurs a phenomenon which does not occur with the internal bone whose conditions do not require it.

At the extremities first, the deposit of earthy salts goes on till this fills up the canals leading from the periosteum to the Haversian canals, so that the circulation through them is obstructed; and from these points complete condensation goes on till it reaches the lower extremity, when the communication between the external and the internal blood-vessels becomes completely severed. Now it is that the animal is prompted by some natural impulse to rub off this outer covering while yet it is gorged with blood. It comes off in long strips or shreds, which look like red cords suspended from the antlers and cover the animal with blood wherever they can reach and stain the trees and branches which he uses for the purpose. During this time the animal seems excited and even fierce. I *suppose* that this impulse to rub off the velvet arises from an irritation created in this thick vascular covering, from the fact that the arteries are pouring into it their full volume of blood, while the imperfect venous system with which it is provided is unable to return the blood sufficiently now that it is cut off from the veins within the antler which had principally performed that office before the surface canals had been closed.

While this has been progressing on the surface, the growth within has been progressing also from the nutriment received by the internal arteries. The cavities in the branches and the upper portion of the beam pretty soon become hardened, like ivory throughout, and the solid wall on the lower part much thickened. Before the central section has become solid, the nutrient vessels are obstructed below, and the deposit of bony particles is arrested while yet the larger portions of the antler are more or less porous, leaving what may represent the medullary canal, braced in every imaginable direction by thin plates of bone, constituting the walls of the cells, thus leaving the antler lighter, but nearly as strong as if it were entirely solid. The extent of this porous section and its density differ very much in different specimens; still it is present in all, to a greater or less extent. The active internal flow of the blood continues longer in young animals than in old, after the velvet is rubbed off. Sometimes the blood will flow appreciably when the antler is sawed off near its seat, two or three months after the velvet has been discarded, while in aged animals after that time, the *plasma* principally passes up into the antler.

In the meantime, the lower extremity of the antler, that convex part below the burr, which sits in the concave seat which is the top of the pedicel, has been solidifying much more rapidly than the internal portion above; and before the cells above had become too much filled up, the lower convex extremity, which, during the active growth of the antler, was traversed by the canals of all the internal blood-vessels leading to or from the antler, becomes more and more compact till finally these canals become completely filled up and the circulation above cut off. This lower crust now much resembles the articular bone terminating the internal bones at the articulations. It resembles it in its extreme solidity and larger granules, which any one can see on the roughened surface by inspecting any deer's antler which has been dropped from the living animal, for they are well exposed by the absorbent process to be presently described.

While nature has been doing this work another and a very anomalous work has been progressing in an internal bone.

The pedicel, which during the active growth of the antler was open and porous, allowing the internal blood-vessels to pass through it freely, so soon as the great demand for nutriment had ceased, commenced a new deposit of laminæ in those canals, which before the commencement of that new growth had been enlarged by absorption, until the blood-vessels passing through them are collapsed, and so the circulation through them arrested. This has become necessary in order to furnish a strong firm base for the antler while it is used as a weapon of warfare, which was not required during the growth of the antler, when the pedicel was spongy and weak. This annual destruction and reconstruction of bone tissue nowhere else occurs in the internal animal economy, and nowhere else do exigencies require it.

Now that all sources of nutriment, both external and internal, have been cut off from the antler, it dies and becomes a foreign body on the living animal, and as nature cannot tolerate this for a great length of time she has provided the means for discarding the inert body and presently sets those means in motion. One of the three systems of blood-vessels first described has not yet been destroyed. Those leading from the periosteum into the articulation still penetrate the seam although they cannot penetrate the solid crust now firmly united to the persistent pedicel. The absorbents of these blood-vessels now commence active operation and undermine the antler. They do not carry away the surface of the bone evenly so as to leave it smooth, but as it were they remove alternate particles, or rather alternate groups of granules, till the union, which before was so firm that no force could break it at the point of junction, has become so weakened that the antler drops off or is detached by some slight violence. This process of absorption requires about one month's time. As before stated the blood now flows freely from the blood-vessels of the periosteum of the pedicel which had penetrated the seam, now ruptured by the removal of the antler. If we now examine the butt of the antler we shall find the surface very rough, like coarse sand-paper, resulting from the unequal absorption before described.

We shall also find it of a most immaculate whiteness without the least trace of blood coming from it, although it is sometimes stained with the blood from below.

Space will not now permit me to pursue the subject and explain the peculiarities of the growth of the antlers on the emasculated buck, and show why it is that they never mature so as to be thrown off, but are persistent through a long course of years, even to the death of the animal.

REVIEWS AND BOOK NOTICES.

Young's Physical Geography.[*]—This is a terse and excellent compilation by one who, as formerly connected with the geological survey of Great Britain and now a teacher of geology, knows how to meet the wants of students. As the preface was written in November, 1873, and the latest information given concerning the results of deep sea dredging and other explorations which have thrown so much light on the geology of the globe, we may feel sure that it contains very late information. The views on the formation of continents and theoretical considerations regarding the geological cause of the present distribution of animals and plants are sound. The author insists upon the extreme antiquity of the continents and the fact that the present ocean beds have always been such.

---

[*] Physical Geography. By John Young, Regius Professor in the University of Glasgow. Putnam's advanced Science Series, New York. 12mo, pp. 368. [1874, no date on title page.] $1.00.

The main drawback in the book is the almost entire absence of illustrations, of which there are not a dozen. The reader, however, is constantly referred to a map. While an excellent book for the British student, the American reader will labor under the disadvantage of reference to the local geology of Scotland and England, to the exclusion of the broader views to be derived from a study of the physical geology of his own continent. Compared with the physical geography of our own Guyot, we miss the elegant diction and broad generalizations of the leading physical geographer of his time. The American "Physical Geography" with its beautiful illustration and maps, which appeal so forcibly to the eye, is a much more valuable aid to the naturalist. Young's, however, is an excellent book to read in connection with Guyot.

Half Hours with the Microscope.[*]—The issue of "Putnam's Popular Manuals" has furnished us a new edition of this best of books for beginners who take up the microscope as a recreation or as a means of studying general natural history. The new edition includes all the advantages of the first. Something between a catalogue of objects and a treatise upon them, it groups together, in a manner both convenient and sufficiently natural, a large number of fascinating microscopic views. The clear and numerous illustrations by Tuffen West, which are rather constructions of the objects than drawings of any one possible view of them, are not on that account imaginary and faulty as has been claimed, but all the better adapted to their purpose.

With the exception of the considerably and judiciously enlarged introductory chapter on the structure of the microscope by the author, in which the binocular receives such unqualified approval as it deserves and receives from those who use it for similar work, and a good half-hour, by F. Kitton, with polarized light illustrated by a bright chromo-lithograph, this edition is not much modernized nor is it much the worse for remaining as it was originally constructed.

---

[*] Half Hours with the Microscope; being a popular guide to the use of the microscope as a means of amusement and instruction. By Edwin Lankester, M. D. Illustrated from nature, by Tuffen West. New York: G. P. Putnam's sons, 1874.

The appendix by Thos. Ketteringham, on the preparation and mounting of objects, is useful to beginners, though somewhat more in need of revision than the body of the work.—R. H. W.

BOTANY.

Sex in Plants.—The remarks of Dr. John Stockton Hough on sex in plants (p. 19, American Naturalist, 1874) are so kind and complimentary to me, that only a desire to aid science, a desire I am sure my friend will respect, leads me to offer the following remarks.

That Dr. Hough has mistaken my views is clear, from his suggestion that I should have used the word "development" in my papers. Nothing was further from my thoughts. I have endeavored to show that sex is determined before development begins; and I have used the term vitality or vigor in order to express the determining power. In a field so wholly new, as this question was when I entered into it, I had great difficulty in finding terms to represent the facts properly; but whenever I have used the terms vigor or vitality, I have always explained that I meant by them a high or low degree of life whatever that might be. If two plants or parts of plants equally "developed," were placed under the same circumstances as regards nutrition, and one died while the other passed through uninjured, this I call a test of vitality. In the one case there is a low vital power, in the other a higher; this I have taken as the chief factor in deciding sex, and "development" has clearly no place in the idea.

That Dr. Hough has not read my papers very closely also appears from his quotations. It was I and not Mr. Darwin, who recorded the fact that female branches sometimes appeared on male silver maples; and I also gave the account of Mr. Arnold's ross-experiments, both in the "Proceedings of the Academy of Natural Sciences" of Philadelphia, before the dates he refers to. These are minor errors to be sure, but they lead to the fear that there may be greater ones; and that greater ones do occur is clear from his quoting me as saying that, "In Norway spruces it is only in the fourth or fifth year, when vitality in the spur is nearly exhausted, that male flowers abundantly appear." I never said anything of the kind; Norway spruces have no spurs. Again I am made to build considerably on the Cupuliferæ in my arguments on sex. I have indeed named the oak, the beech, and the hazel, among numerous others incidentally, as plants which would bear out my views; but it is in the Coniferæ, not Cupuliferæ, that I have given in detail the facts.

Any one who will read my papers, as referred to by Dr. Hough, will I am sure not agree with him that they prove his position. His proposition is, "that female plants, like female animals, are less highly developed than males, and are the result of an inferior developmental effort on the part of the female parents." In the first place there can be no comparison between female "plants" and female animals. There is an individualized vitality in the various parts of a "plant," that there is not in an animal, and that vital power which turns food into life is operating in numberless places in the plant, to the one solitary organ in the animal; and in my view it is the varying phases of this vital power as determined by nutrition, in the various and varying parts of plants, which give direction or "development" to the subsequent sex. For instance I have shown that in Pinus, Abies, Picea, Larix, and kindred forms, the female flowers are only borne on those *most favorably situated for perfect nutrition*, and that these many female branches, *after they become half dead*, commence to bear male flowers. How can this favor Dr. Hough's proposition? How can Dr. Hough's proposition be true, if I have truly stated the facts? That they are true I appeal to any one who will take the trouble to examine the trees I have named when in blossom.

I do not think that physiology alone is competent to deal with this sexual question. Morphology must go hand in hand with it. The failures to appreciate this has led my good friend into serious error in his experiments with the corn plant. If he had perceived the common truths of morphology, he would have arrived at just the opposite conclusion to that which he has. "Abridged internodes" are by no means "in other words undeveloped." There is in many plants, and especially in the Indian corn, a tremendous development going on while the "internodes are being abridged. The ear of corn is a complete branch, arrested in its *longitudinal* development. But in its embryonic condition it has more favor than the male. Every blade that forms the "husk" was destined to be a leaf, and every leaf represents a node. Let any one strip the husk from an ear, and in this way he will find that in many cases over a *score of nodes* go to make up the corn-bearing stalk.

Now examine the male branch, with its weak structure and "development," and we find that it exhausted its whole growing force in half a dozen weak nodes, with scarcely the apology for a leaf at any of the nodes. Compare this with the numerous fat husk blades, which are the morphological analogies of the leafy bracts on the male branch, and even Dr. Hough's theory of "development" fails. Then the male panicle is only a female *which has lost the vital power to combine*. If the (usually four) two ranked lower branchlets of the male panicle had the vital power to combine* with an arrested central axis, and the other high vital powers of the female ear also act, we should have an eight rowed ear of corn, instead of a male tassel. "Some of the specimens" appeared, to Dr. Hough, "as if the cob had separated into several segments," because the male tassel had gained more than usual vital force, and came nearly reaching a perfect ear. This, however, is all very clear to those who are familiar with the morphology of the corn plant, but which they may readily be excused for mistaking who have only gone so far as to imagine that "a spike (ear) is only an undeveloped branch, sometimes having two or three internodes it is true, but generally sessile. It answers very well for descriptive botany, but leads to terrible mistakes here.

In regard to Dr. Hough's facts in relation to the sexual changes in the Indian corn, I can bear testimony to their complete accuracy; and I can see that it is only his failure to appreciate their morphological value, and the real bearing of my facts on his own observations, that he has been led to regard them as favoring a view the reverse of mine.

My position is simply this — a male flower and a female flower are essentially the same in their early embryological conditions. Morphology shows that these early identical parts may take either one form (male) or another (female); and I have shown, as I claim, that the physiological law which governs this morphological development, is a higher vital power to turn nutritive forces towards the female than the male transformation — or as I have expressed it in my original paper, "It is the highest types of vitality (not gross development) that take on the female form." — T. MEEHAN.

---

* To understand how high vital power, and the ability to combine parts, go together see my paper on Adnation in Coniferæ in Chicago vol. of Proc. Amer. Assoc.

A NEW RIBES. — Among the Ribes collected in Colorado Territory during the past season by Prof. John Wolf, who was acting as botanist to Lieut. Wheeler's Expedition, I find a form which appears distinct enough to have specific rank assigned it. A description is herewith sent.

RIBES WOLFII, sp. n. (*R. sanguineum* Pursh., var. *variegatum* S. Watson, King's Report, vol. v, p. 100). Shrub, neither prickly nor spiny; two to four feet high; somewhat branching; young branches light brown, minutely glandular-pubescent, angled by two slight ridges, continuing down from the expanded base of the petiole above; branches of the previous year ashy-gray with a deciduous epidermis, which, on being shed, reveals a dark brown bark beneath.

Leaves thickish cordate-orbicular, deeply 5-cleft, lobes rather obtuse, unequally serrate (though hardly doubly serrate). Average of largest leaves two, to two and one-half inches in diameter, with sinus at base one-half an inch deep. Leaves slightly viscid; under surface pale green, with a few short glandular hairs; upper surface smoother and deeper green. Petioles from one-half an inch to one and a half inches long, slightly margined by a continuation of the principal veins of the blade; expanded at base, becoming semi-amplexicaul, and *at times* with the expansion strongly pectinately-ciliate and glandular-pubescent.

Peduncles decidedly glandular-pubescent, one to two inches long, including the raceme, loosely 4 to 10-flowered. Bracts ovate-spatulate, obtuse, yellowish-white, verging to red occasionally, one to two lines long, and one line shorter than the pedicels, which are a little longer than the flowers.

Sepals red, lanceolate, one to one and one-half lines long, *never reflexed.*

Petals red, ovate-spatulate, half as long as the sepals and as long as the stamens.

Styles two, recurved, rising conically from the summit of the ovary, red for half their length and parted to, or below, the middle.

Stigmas slightly capitate.

Fruit when young, strongly glandular-hairy, but never prickly, becoming much smoother with age. Mature fruit not pulpy, maroon or reddish purple, globose, three-eighths of an inch in diameter.

Seeds few to many, distinctly margined all around; with the inner covering longitudinally punctate as seen through the gelatinous coating.

Twin Lakes and Mosquito Pass, Colorado Territory. Among rocks, at an altitude of ten to eleven thousand feet.

It will be seen that this plant approaches both *R. glutinosum* Benth., and *R. sanguineum* Pursh. It is distinguished from the former by being fewer flowered, having shorter racemes and a rounder berry; from the latter by its shorter racemes, relatively shorter bracts and longer pedicels, and erect calyx lobes.

Its nearest affinity is (as suggested also by Mr. Watson) *R. sanguineum* Pursh., of which it may be but a variety. I think it sufficiently distinct, however, to bear the name of its zealous discoverer, Prof. John Wolf. — J. T. ROTHROCK.

PERIODIC MOTIONS OF LEAVES AND PETALS.—These phenomena, on which much has been written both in England and Germany, have been the subject of a fresh series of observations by the German botanist Batalin. He divides the different instances of motion into three groups:

(1.) Rapid automatic motions caused by a special motile organ, the pulvinus, at the base of the leaf-stalk. (2.) Diurnal motions not so rapid but also resulting from a special motile organ. (3.) Diurnal motions belonging to the whole of the leaf-stalk and partially also to the surface of the leaf, but not connected with the presence of a pulvinus. The third of these classes, to which belong the motions of petals which cause the opening and closing of flowers were the special subject of Batalin's observations. The ordinary explanation of the phenomenon has been the different degree of tension in the two sides of the leaf caused by a difference in the amount of water contained in them, which explanation has however already been shown by Pfeffer not to meet all cases. Batalin agrees with Pfeffer's conclusions and he considers the main cause of the motion to be unequal growth of the two sides caused by alternating differences in the light, temperature and turgescence. He believes that the same cause is also one of those most efficient in the other classes of periodic motions connected with special motile organs.— A. W. B.

ASCENT OF SAP IN THE BARK OF TREES.—M. Faivre has recently performed a series of experiments on the mulberry, hazel-nut and cherry-laurel, which he considers go far to prove the fact that the substances which supply the food of plants have an ascending motion in the bark. For this purpose he made perfect or imperfect annular incisions through the bark, or detached pieces of the bark to which buds were attached, or removed entire cylinders of bark from the trunk. The result of the experiments was that the buds always continued their development when the communication remained uninterrupted with the lower portion of the trunk, while, when this communication was completely destroyed, the buds invariably withered away. If the bud was separated by a perfect annular incision, it withered the more slowly the greater its distance from the incision; and in these cases the starch disappeared completely from the portions of the wood above the incision between it and the bud. When entire cylinders of bark with buds on them were removed, the buds continued to develop, and even produced branches bearing leaves.—A. W. B.

BOTRYCHIUM LUNARIA SWARTZ, IN MICHIGAN.—Last summer (August 14, 1873), I found this rare fern on one of the small rocky islands which lie off the southwest end of Isle Royale, Michigan (Lake Superior), which, from its general outline, I have named Triangle Island, it being unnamed hitherto on any of the maps.

This is an important addition to the flora of Michigan; and though I am aware that the plant had already been discovered on Lake Superior, I am assured that this is the first time of its being found within the limits of the United States.

The plants, of which I collected between thirty and forty, grew on the exposed sand-rock, among matted tufts of dwarfed *Potentilla tridentata* Ait., grass, and other plants. They are remarkably fine, well developed specimens, and quite characteristic. The island is not wooded.—HENRY GILLMAN, *Detroit, Michigan.*

ABSORPTION OF AMMONIA BY THE AËRIAL PARTS OF PLANTS.—A point of considerable practical importance to agriculturists has been recently investigated in Germany, by M. Adolf Mayer of Wiesbaden, viz., whether the aërial parts of plants have the power of absorbing ammonia or not. He carried out a series of experiments on plants growing in such a manner that access of ammonia through the roots was prevented, while the leaves were subjected to the influence of this substance in either a gaseous or dissolved condition. The upshot of his experiments was that a variety of plants subjected to these conditions all had the power of absorbing carbonate of ammonia by their aërial parts both in the gaseous and the dissolved condition and of employing it in the building up of their tissues. The plants did not appear however to thrive when the access of ammonia through the roots was entirely prevented. The experiments did not indicate that Leguminosæ have any special aptitude for absorbing ammonia through their aërial organs, nor for assimilating the combined nitrogen of the atmosphere.—A. W. B.

ZOOLOGY.

PET SPIDERS.—Veritable pets they were, and why not? We hear of pet cats, pet monkeys, pet toads, and an English naturalist had his tame wasp; then why not pet spiders? But without considering why or why not I had them and enjoyed them for several months. The account which I now give of them is written from notes taken several years ago. I did not then nor do I now know the genus to which these spiders belonged, but think they may have been of the genus Lycosa. There were two taken at different times; the first I found under a stone, the second was brought to me pretty thoroughly benumbed with wet and cold, having been taken from a tub of water. I had already provided a domicile for my first capture in the shape of a large cigar box, covered with a pane of glass, and watched with some interest its reception of a new inmate, half expecting it would make an onslaught on the weaker one and kill it for its intrusion, but it manifested no interest whatever, until, enlivened by the warmth, the new comer began to move about, then it was evidently somewhat disturbed and kept to its own side of the box, and the stranger on coming to life enough to realize the presence of its fellow did likewise. Thus for a day or two they were exceedingly shy of each other, but in the course of a week their fear wore away and they were peaceable companions enough, but this amicable arrangement promised to end suddenly, as I thought, at one time, for while I was watching them they ran toward each other; as they met, rising on their hind legs, with the fore legs of each resting on the other's head and body, with jaws widely distended, they appeared as if about to engage in regular battle, but in a moment they dropped to their feet again and ran away from each other like two kittens at play; this I saw them do many times afterward, always ending in the same manner. I also often saw them chase each other around the box, first one and then the other being the pursuer. I thought then and still think they were at play, for never in any instance did they bite one another, nor manifest an appearance of wanting to do so. The only time I ever saw them exhibit ill temper was when I gave them water to drink, which I did once a day, pouring a small quantity upon the bottom of the box; the spiders always ran quickly to it, and oftentimes would stand with all their feet in the little puddle that I made for them, drinking long and steadily, and sometimes in their eagerness crowding each other; then one would seem to lose his temper and would drive the other away from the water. Another and very neat way I had of supplying them with water was with a piece of whalebone split fine at the end to form a sort of a brush; this would hold a drop or two. I held it near to one of the spiders, but high enough to oblige it to rise on its hind legs almost erect to reach it; this either would do as readily as a dog would have risen to my hand for a piece of meat; after the first two or three times that I supplied them in this way, sustaining themselves by resting the fore legs on the whalebone, sucking the brush dry before letting go of it. After a time I did not need to bring the whalebone near to them. I would merely show it inside the box and there was a run for it, the first one reaching it getting the first drink, the other awaiting its turn; it was a matter of surprise to me that they cared to drink so often and so much. I had supposed spiders were capable of sustaining long fasts, both in eating and drinking; in fact the experience of others teaches us that such is the case, but in this instance they were ready to drink at least once a day.

I supplied them well with flies for food and closely watched their method of taking them. The motion of a cat creeping upon a bird is as good an illustration as any of the method; the spider would creep to within the distance of an inch of the fly, stand perfectly still a moment and then throw the body forward as far as the length of the hind legs would admit, the hind feet not moving from the place on which they were fixed, preparatory to the spring. They did not often miss in the first effort, but, if they did, they made repeated attempts until the fly was captured, and after eating it they would set about cleaning themselves, a matter in which they were very precise, commencing with the legs first to clean the body, and afterwards the legs with the jaws and palpi; commencing with the first right leg, then washing the first left, next the second right and so on until all were clean, depositing the accumulated dirt in a minute heap in front of them, pushing it away with the fore legs when they were done. On one occasion I put a common house spider in the box with them, thinking that they would kill and eat it as they were much larger than the new spider, but instead of attacking it they seemed much alarmed and kept as far from it as possible. Thinking they would pluck up courage during the day I did not remove it; at night I found that the house spider had spun a web covering the most of the box, and my pets were stowed away in a corner completely cowed. I removed the house spider, tore out his web and they soon recovered their spirits and were as lively as ever.

I divided the box in which they were confined filling half to the top at one end with soft loam, thinking they would dig a hole in which to conceal themselves when so inclined, but they did not, though I saw evidence several times of their digging; in one instance the soil being excavated to some depth, but irregularly, having no appearance of the smooth round hole that we find in the fields dug by this or an allied species. I supplied a paper tube of suitable diameter and about three inches long, and this they both used, though rarely both at the same time; in only one or two instances did I find them both in it.—HENRY L. MOODY.

REPRODUCTION OF A FISH'S TAIL.—In Lyell's "Principles of Geology,"* occurs the following sentence: "The pectoral and tail fins of many fresh water fish, having been cut off, have been perfectly restored in about six weeks' time." As this statement embodies a fact with which many naturalists seem to be unacquainted, I am glad to be able to give it a new confirmation.

In the rooms of the Boston Young Men's Christian Union there is a fine aquarium, well stocked with gold and other fish. Early in the spring of 1873, the well known fish fungus (*Achlya proligera?*) made its appearance in the tank, and several fine fishes died. Among the specimens attacked by the fungus was a young goldfish, which by some unknown means had lost its tail fin. The fungus came out all over the stump of the tail, the fish became sick, and was apparently dying. At the time I knew nothing of the nature of the destructive fungus, but having my attention called to the case, I at once concluded that I had to deal with some parasite, and resolved to try to exterminate it. The only caustic available happened to be strong nitric acid, a few drops of which I applied to the affected tail stump, allowing it to remain a moment or two, after which I rinsed it off in clean water, and restored the fish to the tank. Of course the parasite was killed; the patches of fungus sloughed off, and the sick fish soon became well and healthy. A few days later I thought I saw more of the fungus appearing upon the previously affected part; but, upon looking more closely, found that the appearance was really due to the growth of new rays. In the course of a month a new tail fin, perhaps a fourth of an inch long, had appeared, which continued to grow rapidly, so that in three months from the time of my experiment the fish could not be distinguished from others in the aquarium. The lost tail was reproduced with absolute perfection, the reproduction taking place not only under my own eyes, but also under the observation of several competent witnesses.

---

* Tenth London Edition, vol. ii, p. 478.

This case seems to me interesting as a confirmation of what was already known, and also as showing that the reproduction of the lost part was not prevented even by the application of one of the most powerful and destructive of all caustics.—F. W. Clark.

The Kinglets in New Jersey.—We are somewhat surprised to find it stated in the latest work on North American ornithology* that the two kinglets (*Regulus satrapa* and *R. calendula*) are not *known* to breed in the United States, but that a few are *believed* to remain throughout the summer in Maine, "and probably breed in the dense *Thuja* swamps." Both of these kinglets are quite abundant in New Jersey from early autumn until late in spring, as is well known; and we have twice stated (Geology of New Jersey, 1868, p. 769, and volume iv of this Journal), that a few individuals remain, during the breeding season, among the mountains of Sussex county of this state. Both there and in the adjacent territory of Monroe and Pike counties, separated from Sussex county by the Delaware River, here a narrow stream, the kinglets, in scanty numbers, unquestionably do remain throughout the summer months. As I knew of their presence in June, July and August, I presumed they bred there, very naturally (*both* the presumption and the breeding). In the summer of 1871, I had an opportunity of examining a number of warbler and other small bird skins, and among them were two unmistakable skins of *Regulus calendula*. These skins were marked "Laurel (*Rhododendron*) swamps, Monroe county, Penn., July 11, 1871."

---

*A History of North American Birds by Messrs. Baird, Brewer and Ridgway. Land Birds. Vol. i, p. 73-76, Boston, 1874.

What indeed is more likely than that these birds, which are so abundant during autumn, winter and early spring, should occasionally remain as far south as New Jersey, especially when we consider that the northern portion of the state, and the adjacent counties of Pennsylvania, are all so admirably adapted to their wants and likings? Especially is this true of Monroe and Pike counties in Pennsylvania, where there are almost impenetrable rhododendron jungles and hemlock swamps. Throughout summer, these wild by-ways are always cool and damp, just as a locality some miles to the south, which has already been described in the NATURALIST (vol. ii, p. 39) by T. C. Porter, who says of it, here "the ice accumulates in immense masses during the winter and lies undisturbed until late in the spring." It was here that Prof. Porter sought northern plants and was rewarded "by the discovery of *Sedum Rhodiola* DC.—an inhabitant of high latitudes in Europe and America." Have we not here a precisely similar instance in botany, to that, in ornithology, of the presence of our two kinglets, during the summer months? With our migratory birds the geography alone does not decide all their movements—the geology too has its influence; and this is notably the case with reference to the movements of the countless thousands of warblers that follow the valley of the Delaware on their northward migration in spring; and also with those semi-arctic species that, visiting us in winter, are checked on their return sojourn, as summer approaches, by the dense, damp forests of the Delaware valley, where winter long seems to linger in the air, just as in April, in the hollows of the woods, the unsunned snow is still lingering when the fields and open glades are bright with violets, Epigæa and the columbine. —CHARLES C. ABBOTT, M.D., *Trenton, New Jersey, Feb.* 18, 1874.

THE HONEY-ANTS.—It is but a few years since this animal was described by Westmael, under the name of *Myrmecocystus Mexi-*

canus. What is known of it is still imperfect, and a prolonged study would elucidate many interesting facts.

I first saw this animal last summer in Santa Fé, but it was not till late in the fall that I had occasion to examine its habitation.

A structure like a crater about one inch in diameter indicates where they live underground; they make no hills like other ants. A narrow canal of the diameter of a quill leads several feet deep, it is variously contorted and sometimes widened out to a chamber; in such chambers or cavities are seen stored up five, six and more honey-ants serving as a larder for the others that are not honey producing, the latter performing the other household duties; they are very small and of a yellow color.

The opinion that the honey is discharged into receptacles is entirely erroneous; the only receptacle is their own abdomen swollen up to the size of a pea, clear, transparent; the intestines even being recognized as a narrow canal winding through the rounded and puffed-up abdomen. The strain on the membrane is such as almost to cause it to burst. Many do burst, for on digging up the habitation very carefully, one can often notice specks of the soil entirely saturated with liquid honey, and near by the collapsed ant. In many cases the rupture produces death, and the non-producing ants are seen around such places enjoying the sweet liquor.

The honey has an agreeable taste, slightly acid in summer from a trace of formic acid, but perfectly neutral in autumn and winter; it contains a little more water than the honey of bees, and has therefore somewhat greater limpidity. The Mexicans press the animals, and use the gathered honey at their meals; others prepare by fermentation an alcoholic liquor from it.

It would be worth while for beekeepers to try to introduce them into some kind of bee-hive fitted with a suitable dry soil and the proper food at hand for them.

The average weight of a non-producing ant is two milligrammes, that of a full honey-ant two hundred and forty milligrammes, a contrast simply immense.—Dr. OSCAR LOEW, *Chemist and Mineralogist to Lt. Wheeler's Exploring Expedition.*

SPIZELLA BREWERI (?) IN MASSACHUSETTS.—M. W. Stone brought me a ♂ sparrow shot December 15, 1873, in Watertown, Mass. It was in company with *S. monticola.* I could not identify it with the aid of any of the books I had at hand, and so sent it to H. W. Henshaw, who kindly compared it with the series of *S. Breweri* he took in Arizona, now in the Smithsonian. He replies in substance as follows:— "Though hardly typical *Breweri* it is strikingly that species—at any rate can be identified with no other. The peculiarities may result from a modification by climatic influences, or may be merely individual abnormality. The whole upper parts, but particularly the crown, are almost exactly as in *Breweri* proper (no trace of chestnut on crown); the same is the case regarding relative lengths of wing and tail, the latter being longer than the former in *Breweri* (wing 2·40, tail 2·60 in *Breweri*) wing 2·52, tail 2·63 in this specimen. In *S. socialis* these proportions are reversed. The bill is strikingly diminutive, smaller than in any *Spizella* I ever saw. The bill and feet are darker than in *Breweri*, while a strong ashy suffusion of the under parts, which also to less degree tinges the whole plumage, are points of dissimilarity from the characteristic flaxen or gray-colored shades of *Breweri*, and an approach to *socialis*."—William Brewster, *Cambridge, Mass.*

[Note.—Dr. Coues, on reading the above, says that he carefully examined the specimen while it was in Mr. Henshaw's hands, and agrees that it cannot be distinguished specifically from *Breweri*, though it has some points about it indicating *socialis*, suggesting a possible hybrid of the two.—Eds.]

The Chimney Swift; Change in Place of Nesting.—I see by the Naturalist of December, 1873, that Mr. J. H. Sears, of Beverly, Mass., has noticed *Chætura pelasgia* to forsake the old chimney and build its nest in a barn in company with the barn swallows (*Hirundo horreorum*). A similar instance came under my observation a few years ago. A pair of chimney swifts selected the *end* of a barn *inside*, and there, about three feet below the vertex of the roof, built and reared their young for several years. This was in Lewis Co., N. Y. As this country became settled, these birds deserted the hollow trees of the forest and took up their abode in our chimneys. But here they find, after sad years of experience, that during every heavy rain (unless the mouth of the chimney is very small) numbers of their nests are washed away. And now we see that some of them, at least, have come to the wise conclusion that they are "never too old to learn" and have acted accordingly. Is not this a good example of the influence of civilization and domestication upon the habits of birds, and can it all be attributed to *instinct?*—C. HART MERRIAM.

THE MYRIOPOD CERMATIA POISONOUS.—Day before yesterday, a lady in this house stepped on a *Cermatia forceps* when she was barefoot. It was evening and dark. She thought at first that she had trodden on a carpet tack, but it seemed quite different soon, more like the effects of a coal of fire.

She lighted the gas, and saw the large Cermatia which bit her. It was wounded by her tread and had its revenge. It bit just between the toes and her foot swelled a good deal, and pained her so much that she consulted me. But it yielded to an application of ammonia and camphor.

The swelling and pain continued about thirty-six hours, keeping her awake most of one night.—JOSIAH CURTIS, M. D., *Washington, D. C.*

BLIND CRUSTACEA.—A new and interesting genus of Decapod Crustacea has been described by Mr. Wood-Mason (in the Proceedings of the Asiatic Society of Bengal, August, 1872) which was dredged in deep water off the eastern coast of the Andaman Islands, and which is closely allied to the northern European *Nephrops Norvegicus*, but, like *Calocaris MacAndreæ* of Bell, is destitute of the organs of vision.—Prof. WESTWOOD'S *Address before the Entomological Society of London.*

BIRDS AND CATERPILLARS.—In the very timely article from Dr. Packard in the May NATURALIST, Mr. C. J. Maynard is reported as stating, that no bird but the Baltimore oriole will feed on the tent caterpillar. Last season I noticed that the black-billed cuckoo fairly exterminated this pest in an orchard near the college, though the tents existed in great numbers. Both the robin and blue-jay will eat the larvæ of the *Dryocampa senatoria*, and in eating them have done great service to our state.—A. J. COOK, *Agricultural College, Lansing, Mich.*

A SINISTRAL HELIX ALBOLABRIS.—While collecting land shells with Mr. Anson Allen of Orono, Maine, we found a sinistral shell of the *Helix albolabris* with the animal still alive in it, but as the lip had not been turned, Mr. Allen took it home and kept it till the lip was fully turned.—C. H. FERNALD.

Note on Preserving Insects in Collections.—I have devised a method for preserving insects without the trouble of camphor. No Psocus, nor *Cheyletus eruditus*, nor other pest dares enter a box after I have treated it. Having a clean-papered box I wash it with common carbolic acid (disinfecting solution) with two-thirds water. It dries without any stain, and I find, after many months' trial, a perfect result. Sheets of card thus medicated give me all the small, soft Hemiptera, etc., with antennæ, etc., not eaten by Psocus, as was formerly the case.—T. A. Marshall, *in Entomologist's Monthly Magazine.*

GEOLOGY.

Deep Sea Explorations (Report Brit. Assoc. in Athenæum for Sept. 27).—The largest audience of the week was gathered together on Tuesday morning (the final sitting), to hear Commander J. E. Davis discourse "On the recent Achievements of the Challenger Deep-sea Expedition." Capt. Davis confined himself to the proceedings of the Challenger Expedition north of the equator, which formed a natural section of the voyage. The operations with which he chiefly dealt were the deep-sea soundings viewed in their relations to physical geography rather than to zoology, which, as is well known, occupies a large portion of the attention of the scientific staff of the Expedition. He described and exhibited to the meeting the various mechanical contrivances adopted to sound the greatest depths with accuracy, ascertain the temperatures, and bring up mineral and zoological specimens from the bottom. In the course of the voyage outward from the Thames to Gibraltar, and thence to Madeira and the Canaries, the first interesting set of soundings were taken off the entrance to the Straits of Gibraltar. The soundings over a large area in this section are as follows: just beyond the meridian of Cape St. Vincent, due west of the straits, 2,500, 2,125, and 2,250 fathoms; and, again, between Madeira and the Canaries 2,350, 2,400, 2,200, and 1,975 fathoms; but westward and northward, outside this area, the depths diminish to 1,525, 1,400, 1,550, and 1,650 fathoms. These results seem to indicate the existence of another deep basin outside the Mediterranean, circumscribed by a ridge similar to the two deep basins within that sea. Great depths were found close up to the islands of the Madeira and Canaries group, but a much more abrupt elevation from the sea-bed was presented in Bermuda. The deepest sounding yet made in the ocean was at a point eighty miles distant from these islands, where a depth of 3,875 fathoms was found. Five miles of rope was run out with the sounding apparatus, taking one hour and twelve minutes in its course. The other soundings taken around Bermuda prove it to be a peak, formed by coral animals, rising abruptly from the abysmal depth of 1,500 to 1,820 fathoms — comparable, as Dr. Carpenter observed, to the Matterhorn. Between the West Indies (St. Thomas) and the Canaries, nearly in the middle of the Atlantic, shallower depths were found, showing that a submarine ridge here exists. The depths over the ridge are 1,900 and 1,950 fathoms, whilst on either side of it a broad basin extends, deepening to 2,650 fathoms in the western basin, and 3,150 fathoms in the eastern. In crossing from Bermuda to the latitude of New York, especial attention was directed to the Gulf-Stream, both as to the depth and temperature of the current. A sounding of 2,425 fathoms was obtained just within the southern edge of the famous stream. From serial temperatures taken at various depths in the stream, it was found that in this part of its course the warm water does not extend beyond 100 fathoms in depth. It was found to be 57 miles broad, rapid only along the western edge, where there was a belt of water 15 miles wide, running 3½ to 4 miles an hour, and 3° Fahr. higher in temperature than the other parts of the stream.—*American Journal of Science.*

ANTHROPOLOGY.

A HUMAN SKELETON FROM THE DILUVIUM.—M. Rivière who discovered the famous human skeleton at Mentone in 1872 has recently (March, 1873) exhumed another in the cavern of Baouné Roussée at Venti Niglia near Mentone in the South of France. The cavern is twenty-seven or twenty-eight metres above the level of the sea and about twelve metres deep. The ground is covered by a layer of red conglomerate about a metre in thickness. Beneath this layer are large blocks of stone which appeared to be piled up about the entrance and among these blocks were found the first traces of a human dwelling. Round about were scattered bones of the genera Cervus and Capra mixed with shells of Patella and Mytilus and a few stone and bone implements. At a depth of three and three-fourths metres below this upper habitation was found a second with numerous animal remains, the age of which did not admit of a doubt, and among them a human skeleton. The most important among the animal remains were bones of the hyæna, horse, marmot, *Ursus spelæus*, *Bos primigenius* and various species of deer, but none of the reindeer; also numerous remains of birds, and of land and marine mollusks. The weapons and instruments were made partly of bone, partly of stone, and belong in no case to the period of polished stone implements, but to the oldest stone age; some of the smaller instruments were made of quartzite or felsite. The human skeleton was not in so good a state of preservation as the other previously discovered; it lay extended on its back near the entrance to the cavern, the ground round it being covered with a stratified deposit of ashes, charcoal, fragments of bone, teeth of animals, mussel shells and stone implements. The height of the skeleton must have been, when perfect, as much as two metres or a little over, *i. e.* about six feet, six inches. M. Riviére refers without hesitation both the skeletons found near Mentone to the older stone age, about the end of the epoch of the cave-bear and *Rhinoceros tichorhinus*.—A. W. B.

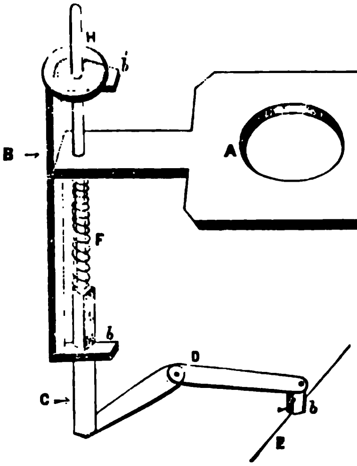
MICROSCOPY.

Arranging Diatomaceæ.—The convenience of having diatomaceæ arranged for observation is appreciated by all who make a study of this attractive branch of microscopic research.

The first requisite is a mechanical finger which may be had very cheaply after the following pattern:—A plate *A* (Fig. 79) is attached to the body of the microscope by the objective of from 1 inch to $\frac{2}{3}$ inch. To this plate is attached the part *B* perpendicular to *A*; this has the projections *b* and *b′* through which works the sliding shaft *C*, the lower part of which is square fitting accurately in the projection *b*. The shaft, the upper part of which is furnished with a screw-thread, is raised by turning the milled head *H*, the spiral spring *F* moving it downward. The arms *D* are attached to the shaft and to these the needle holder *d* in which the needle is placed at an angle of about 45°. This finger can be used with nicety with a little practice, and can be made by any one that has a little mechanical ability. I have made one that did not cost over 25 cents for the materials.

The other requirement is a stage plate to carry the thin glass cover. It should be about $1\frac{1}{2} \times 4\frac{1}{2}$ inches, upon which is made to revolve a turntable represented by Fig. 80. *A* is the plate. *B* the turntable, the use of which in locating the object is apparent, *C* an aperture about ¼ inch in diameter for the transmission of light to the cover on which the arrangement is being made.

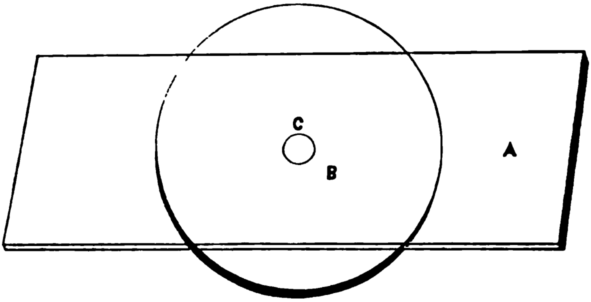
Fig. 79.



The cover should be coated by a very thin film of the purest gelatine dissolved in distilled water.

The process is now easily consummated. The cleaned diatoms being evenly spread upon a glass slip and the slip placed upon the stage, select the specimen desired, let the sliding shaft down

Fig. 80.



by turning the milled screw till the point of the needle (which should be very fine, or a bristle may be used if preferred) touches the object, give it a few backward turns to lift it clear, then more rapidly by means of the coarse adjustment of the microscope; substitute the stage plate with the cover attached to it by some kind of cement and carry the plate, by means of stage movement, so that the object may be let down in the required position on the glass cover. Another may then be placed beside it, etc. After completing the arrangement, moisten the glue by breathing upon it or holding in the vapor of distilled water, though the latter is liable to wash the objects out of place unless dextrously managed. They are then secure and will sometimes bear rough usage in mounting without becoming displaced. Occasionally there will be a specimen that will adhere to the needle so persistently that we are liable to consider patience no longer a virtue. In such cases try another specimen, as different diatoms of the same species vary greatly in grade of difficulty. My experience is that discoid forms are most easily arranged and the light Naviculæ the most difficult. Sometimes air prevents the balsam from entering the frustule, which may be avoided by separating the valves of such as will admit of it, when time is of no consideration.

Thus any one of the requisite mechanical tastes can have slides of diatomaceæ arranged in squares or otherwise to suit the fancy, and a large number of specimens be examined without change of slides. The finest specimens may be thus secured, from impure gatherings, and reference made to any particular specimen without the use of the "finder."—W. W. RINER, *Greene, Iowa.*

HISTOLOGY.—Dr. James Tyson's magazine article, narrating his experience in the laboratories of Dr. Klein of London and of Prof. Stricker of Vienna, has been raised to a little book and published by Lippincott as an Introduction to Practical Histology. The additions to the original article are not extensive, but are designed to make it more comprehensive and more available as a hand-book for actual beginners in histology. While almost every microscopical treatise is full of mounted objects and mounting objects, it is refreshing to find even a small work which says hardly a word about either, but devotes itself entirely to microscopical study. Like most histologists, the author values highly the vertical use of the microscope, and says little of the binocular instrument.

He believes the "vegetable spores" of Salisbury and the "elementary corpuscles" of Zimmermann are fragments of the larger colorless blood corpuscles. For embedding tissues preparatory to cutting sections of them, he pins them into the centre of little boxes extemporized out of white paper, and pours the melted embedding material around them; seeming to prefer for this purpose the medium suggested by Dr. J. G. Hunt, which consists of common transparent soap cut into small pieces and melted in a water-bath with the aid of alcohol, this being a cleanly and transparent material which can be kept in a bottle and easily melted (by placing the bottle in warm water) and poured out when necessary. The only serious mistake in the book is the measurement of the image, in estimating magnifying power, at the distance of the stage instead of at ten inches; an erroneous procedure repeatedly pointed out by us in other cases, and in this case beautifully illustrated by the direction on the same page to measure it, when using the camera lucida, at the distance of ten inches, which of course would give the same results in exactly those instruments whose stage happened to be ten inches from the observer's eye. On the whole, beginners in histology should thank Dr. Tyson for a neat, handy, and timely work whose usefulness is far in advance of its size.

MORPHOLOGY OF THE SAPROLEGNIEI.—This doubtful family, that seems now finally deposited in the algæ, has now considerable economic interest from the destructive effects produced upon fish eggs in the hatching trays, supposed to be caused by *Achlya prolifera*. The following summary is translated from advance sheets of "Contributions to the morphology and systematic relations of the Saprolegniei;" by N. Pringsheim. (Jahrbuch für wissenschaftlicher Botanik, ix, Bd. 2tr. Heft.)

The results of my investigations on the Saprolegniei may be condensed as follows:

1. In all the Saprolegniei the male organs of generation develop from the well known antheridia, that are formed near, or grow toward the oogonia.

2. Those in which antheridia or their equivalents are wanting, are not, as has been supposed, distinct species, with modified organs, but parthenogenetic forms, whose sporangia ripen and bud without fertilization.

3. In the Saprolegniei there is but one kind of sporangia; those which develop parthenogenetically, and those which are fertilized are identical, and show no difference originally. The unfertilized zoospores grow sooner and more readily than those which are fertilized.

4. Several peculiarities in the formation of zoospores, which have been considered sufficient specific distinctions, are not important as such, but are merely evidences of a greater or less tendency to dimorphism, representing various stages of development in the zoospores.

5. Also various sexual forms of growth may appear in the same species, which are not reliable as specific distinctions.—W. H. S.

Section Cutters.—At the Queckett Club, Mr. T. C. White alluded to the impracticable expensiveness of many excellent section cutters, and stated that he had used with great success a contrivance, which consisted of a brass tube fastened at right angles with a brass plate, upon which a glass plate with a corresponding aperture was cemented for a cutting surface. The substance to be cut was embedded in an inner tube which was simply pressed up by the finger when required.

Mr. Walter White read a paper on the "Science-Gossip" section cutter in which the plug holding the object is raised by slight blows upon a wedge, instead of by a screw.

The President, Dr. R. Braithwaite, said that he did not possess a section machine, but was accustomed to cut sections of sphagnum and other leaves by inserting them in a slip of soft cork and cutting them by hand.

Lecture-illustrations of Microscopic Objects.—Rev. W. H. Dallinger has communicated to the Royal Microscopical Society an improved method of preparing transparencies for use with the lime-light and lantern. He finds large drawings unsatisfactory for a large audience, as well as incomplete in detail, unless prepared with great labor and skill, and the usual transparencies for screen use, whether photographed or painted, cost too much time and labor to be always available. To obviate these difficulties, he draws the magnified image on a surface of finely ground glass of the size of a magic-lantern slide. The drawing is as easily done as upon card, using a black lead pencil, and the camera lucida if necessary. Colors may be added, if desired, by a sable-hair pencil. The surface is then protected, and the drawing instantly changed into a transparency, by flowing thin balsam over it and allowing it to dry as a thin film over the surface. In the same manner illustrations of subjects not microscopical may be easily and rapidly prepared.

PODURA SCALES.—A happy accident has furnished Mr. F. H. Wenham a supply of specimens that seem to confirm the theory he so strongly defends of the reality of the spines on this most disputed of "tests." A favorite specimen which contained a detached spine having been destroyed, and an effort to remove uninjured the large scales which adhered to the broken cover-glass having failed, he scraped off the scales at random with a sharp knife edge and mounted the fragments, and was pleased to find many of the fragments cut obliquely in such manner as to leave the spines (!) cut at a different plane and manifestly projecting beyond the other portions. Mr. Wenham's drawings certainly seem to confirm his descriptions, and photographs of the same appearances are promised.

LENGTHENED IMMERSION TUBE.—Mr. E. Richards, of the Royal Microscopical Society, renders the familiar immersion arrangement available in deep water, eight to ten inches, by screwing in an adapter between the objective and the nose piece of the microscope. This carries the objective with its immersion cap down through the stage and into a tank of water beneath it.

AUTOMATIC TURN-TABLE.—Dr. F. B. Kimball prefers this arrangement to the usual method of turning by hand. He uses the works of a common clock, putting a pin through the shaft of the table and cutting a slot in the hand arbor of the clock-work, and then mounting the turn-table so that the pin will catch in the slot and the two move together.

ORIGIN OF BLOOD CORPUSCLES.—Dr. H. D. Schmidt, of New Orleans, has communicated an elaborate study of this subject to the Royal Microscopical Society. His studies were chiefly directed to human embryos of six weeks old, and upward. He is convinced that the nucleus only, of the colorless blood-corpuscles, is developed into the red corpuscle. He strongly confirms the prevalent opinion that the spleen and lymphatic glands are the permanent blood-formative organs. He looks upon the blood corpuscle as a gland-cell destined to promote within itself the transformation, into other elements, of certain materials derived from the liquor sanguinis, and when matured to give back directly "to the liquor sanguinis, by its final dissolution, its secretion, consisting of its own body."

SUBSTITUTE FOR THE CAMERA LUCIDA.—Mr. W. Kesteven, Jr., substitutes the thinnest possible cover-glass for the tint-glass commonly used for camera lucida purposes. He does not appear to suffer from the difficulty of too great transparency which has deterred others from its use.

NOTES.

Two months ago, in announcing the provision made by the Legislature of Kentucky for a geological survey, we asked whether the time were not coming for a careful geological and zoological survey of Massachusetts. Since then, active measures have been taken to secure this result. The American Academy of Arts and Sciences (the oldest and highest scientific body in the state) has petitioned the Legislature, and a memorial, referred at first to the Committee on Education, has now been placed in the hands of the Board of Education with instructions to investigate the matter and report at the assembling of the next legislature. The memorial of the Academy, before its adoption, was thoroughly considered by a special committee, consisting of the President (Hon. Charles Francis Adams) Professors William B. Rogers and T. Sterry Hunt, and Messrs. George B. Emerson, Alex. Agassiz, S. H. Scudder and R. H. Dana, Jr., so that we can have no doubt of a favorable report from the Board of Education.

The publications of such a survey, says the Academy, in its memorial, should embrace a detailed topographical map, on a scale of about an inch to a mile, maps colored to show the distribution of rock-formations and economic minerals, with charts on a larger scale of particular localities, having special interest or importance; sections and explanatory text to accompany these maps, embracing descriptions and analyses of the rocks and ores and of the waters, and investigations into the strength and durability of our building-stones; full descriptions and truthful illustrations of the animals and plants, including their natural history, transformations and relations to man and his requirements.

The memorial goes on to show that in carrying out the survey the State could take advantage of the provision made by Congress, by which any State undertaking a topographical survey of its territory is empowered to call upon the United States Coast Survey to make the preliminary triangulations, so that the State is at once relieved of a very important part of the work to be done. In making these triangulations, the Coast Survey utilizes the experience of local professors and their students; and in the same way, it would be entirely feasible, in following the trigonometrical with the topographical survey, to employ the services, in different parts of the State, of the same persons. The survey would thus become at once a most valuable auxiliary to scientific education, by giving the younger men in our schools of science and technology an opportunity to put their studies to practical use.

The Academy places in a conspicuous light the educational advantages which would accrue from such an undertaking and urges that the reports under the proposed survey should, as far as possible, be prepared with special reference to an intelligent use by the people; and that, instead of being distributed gratuitously, they should be sold through the ordinary agencies at a slight advance upon the cost, so as to enable the State to pay the authors from the proceeds of the sales, and to recover the greater part of its original outlay, without placing the books beyond the reach of persons of moderate means. Such a mode of publication would unquestionably be the most economical for the State, and the most certain to bring the books directly and naturally into the hands of those who would value and use them.

These suggestions are timely and important, and if faithfully followed, would reduce by one-half the ordinary expenses of such a survey. One or two further suggestions, however, are needed: that the Legislature should at the start ensure the continuance of the survey for a term of years, ten or fifteen at least; and that the appointments should be removed from the domain of politics or of personal preferment. Why should not the nominating power be intrusted to such a body as the American Academy? This measure would give confidence in the success of the survey.

We bespeak from our Massachusetts readers all the aid they can render in this matter. If the movement fail now, it may be years before we can hope to see it urged again with the least chance of success. Educational institutions and associations should bear their testimony to its importance, and every one interested in the cause of education, every lover of nature should make this a matter of public notoriety and public interest, and obtain for it the hearty coöperation of members of the coming Legislature. We shall revert again to this topic and keep our readers acquainted with any new development.

Necessity of a Common Language in Natural Science. "It may be asked why I, in my catalogue of arachnological literature, have not included any other works than those written in Latin or in the living languages of Teutonic or Roman origin. The reason is, not that I undervalue what may have been written in other languages (which I am very far from doing), but simply that I am unable to understand even the titles of works written in, for example, Russian, Polish, Bohemian, Finnish, or Magyar; and thus I have only by accident come to learn that a couple of works in these languages treat on arachnological subjects.

"It may in general be taken for granted that a person of liberal education has some acquaintance with Latin, and knows at least one Teutonic and one Romanic language; and when this is the case, he can, without any great waste of time, learn so much of the others as to be able, with the help of a grammar and a dictionary, to understand the purely descriptive works within his own department that are written in those languages. This is probably the reason why, in determining questions of priority, it is customary to attribute as much importance to works written in, for instance, Portuguese or Swedish as to those written in any of the more generally studied languages. But it is, of course, impossible to assign the same weight to *all* languages. No naturalist can have time to acquire the knowledge of all the *European* languages which have already a scientific literature to show; and the languages of this part of the world will assuredly not long continue to keep exclusive possession of that territory. It would seem, therefore, to be absolutely necessary, even for the future, in the selection of the works of which a zoologist or botanist ought to be expected to possess a knowledge, and which, in the determination of questions of priority, ought to be taken into account, to confine one's self to those which are written in the living languages of Teutonic or Roman origin and in Latin.

"The want of a *common* scientific language will unquestionably become gradually more and more felt; and as a return to Latin can hardly be expected, it is not improbable that *English* may sometime or other acquire that rank, not only because that language is far more widely diffused over every part of the earth than any other culture-language, and that already two of the greatest nations publish in it the results of their scientific labors, but because English, on account of its simple grammar and as combining in nearly the same degree Teutonic and Romanic elements, is by most Europeans more easily acquired than any other language."—*Remarks on Synonymes of European Spiders*, 1873, p. 583 (a work written entirely in elegant idiomatic English).—By Prof. T. THORELL, of Upsala.—*Annals and Mag. Nat. History.*

We may add that De Candolle, the Swiss botanist, has lately advocated the use of the English language as a common scientific language, and in this connection we quote the remarks of Mr. G. O. Sars, the well known zoologist of Norway, in the introduction to his elaborate work on animal life at great depths off the Norwegian coast.

"That I have chosen a foreign language instead of my mother tongue, as the medium of this communication, is a circumstance which I think does not call for any justification on my part. Science is cosmopolitan, and therefore requires a generally intelligible language. Our language has not reached this point yet; and to facilitate the reading of this little work, I have adopted one of the great universal languages. I have preferred the English language, as well because it has most affinity with our own, and consequently affords greater facility for rendering the Norwegian expressions, as in acknowledgment of the great progress which zoological science has made in recent times, through the medium of the English languages."

THE present indications are that the meeting of the American Association for the Advancement of Science, at Hartford, in August, will be one of unusual interest and will be largely attended. The citizens of Hartford have commenced the work of making arrangements for the meeting with great enthusiasm, and the well-known liberality and wealth of the city make it certain that the local arrangements will be made as perfect as possible. As favorable to the success of the meeting we notice a new feature in the local sub-committees, that of the appointment of a number of ladies as a Committee of Reception. The circular of the Permanent Secretary of the Association has been issued, and that of the Local Committee will soon follow. When the latter is published we shall give a summary of the local arrangements. The circular of the Permanent Secretary, as well as the necessary blanks for the entry of papers to be read at the meeting, and for application for membership, can be obtained by addressing him. There are hundreds of persons in the country who, though deeply interested in its object, are not yet members of the Association. Many would join the Association and aid in its work if they were more fully acquainted with its rules and character, and such we recommend to apply to the Permanent Secretary for further information. Among the business matters to be attended to at the meeting, will be the acceptance of the Act of Incorporation giving a legal existence to the Association; while the new Constitution proposed at Portland will be acted upon. We learn that the Portland volume of Proceedings is nearly printed, and that it will contain many of the most important papers read at the meeting. A number of members whose papers were accepted for publication have not sent in their manuscripts, notwithstanding the very long time allowed them to do so. We also learn that the Committee on the donation by Mrs. Thompson have accepted and commenced printing a monograph on "Fossil Butterflies," by Mr. Scudder. This work, which will be an exhaustive treatise on the subject, fully illustrated, and of quarto size, will form the first of the special memoirs of the Association, and in every way will be worthy of the liberal patroness. The following are the officers elected for the Hartford meeting which will open on August 12th:—*President*, Dr. J. L. LE CONTE, of Philadelphia, Pa.; *Vice President*, Prof. C. S. LYMAN, of New Haven, Conn.; *Permanent Secretary*, Mr. F. W. PUTNAM, of Salem, Mass.; *General Secretary*, Dr. A. C. HAMLIN, of Bangor, Me.; *Treasurer*, Mr. WILLIAM S. VAUX, of Philadelphia, Pa. *Standing Committee*, *ex officio*, Ex President, Prof. JOSEPH LOVERING, of Cambridge, Mass.; Ex Vice President, Mr. A. H. WORTHEN, of Springfield, Ill.; Ex General Secretary, Prof. C. A. WHITE, of Brunswick, Me.; President, Vice President, Permanent Secretary, General Secretary and Treasurer of the Hartford meeting. *Local Committee:—Chairman*, Hon. H. C. ROBINSON; *Vice Chairmen*, Prof. JOHN BROCKLESBY, J. M. ALLEN, Esq.; *Secretary*, Rev. W. L. GAGE; *Treasurer*, GEO. P. BISSELL, Esq., and one hundred and one other citizens.

THE FRENCH ASSOCIATION for the Advancement of Science.—We copy the following from an extended notice in "Nature," as showing the high stand the French Association has taken, and the cordial support it has received, and also as containing suggestions that the American Association might, with proper modifications, follow to great advantage:—

"The first volume of the yet young French Society's Proceedings does it infinite credit. It is a handsome, beautifully printed volume of 1,330 pages, containing upwards of 200 papers, addresses and lectures on a wide variety of subjects, connected with science, pure or applied. The volume is also well illustrated, some of the plates appended being coloured, a feature which we think the British Association would do well to imitate in its 'Proceedings.'

The French Association, as our readers no doubt know, made a very auspicious start, the number of members amounting to somewhere about 800. There are two classes of members—1st, *membres fondateurs*, who subscribe one or more shares of the capital of the Association, a share amounting to 500 francs; there are about 250 members of this class, some of whom have subscribed several shares, among the latter being a considerable number of railway and other public companies; 2nd, ordinary members, paying an annual subscription of 20 francs, or a life-subscription of 200 francs; the names of about 50 life-members are in this volume. After an existence of scarcely three months, the Association possessed a capital of nearly 140,000 francs, and an annual revenue of more than 16,000 francs.

The French Association is modelled pretty closely after the older British one, its aim being, according to the rules, 'to promote by every means in its power the progress and diffusion of the sciences from the double point of view of the perfection of pure theory and of the development of their practical applications.' These ends it proposes to accomplish by means of meetings, lectures, publications, and donations of instruments or money to persons engaged in scientific researches. It appeals for help to all those 'who believe that the cultivation of science is necessary to the greatness and the prosperity of the country.'

The Association is divided into four groups, and each group into several sections; the groups are—1. The Mathematical Sciences; 2. Physical and Chemical Sciences; 3. Natural Sciences; 4. Economic Sciences. The French Association devotes more attention to the practical application of scientific principles than does the British one; the 1st group, for example, including Sections of Navigation and of Civil and Military Engineering: the 3d group including the Medical Sciences, and the 4th group Agriculture."

A SOCIETY has lately been organized in Detroit, Michigan, designated the Detroit Scientific Association, and having for its object the advancement of scientific knowledge in all its branches. At a meeting held on April 16, 1874, the regular election of officers for the ensuing term took place, with the following result: *President*, Dr. Geo. P. Andrews; 1st *Vice President*, E. C. Skinner; 2d *Vice President*, Prof. J. M. B. Sill; *Cor. Secretary*, Dr. A. B. Lyons; *Recorder and Cabinet Keeper*, E. Wolfenden; *Treasurer*, C. C. Cadman; *Librarian*, J. C. Holmes; *Curators*, D. Farrand Henry, Fredrick Stearns, Henry Gillman.

Commencing with a list of over thirty charter members, and with promises of large accessions to the number, the society bids fair to become one of the prominent institutions of usefulness in this city.

After adjournment the newly elected curators held a meeting with a view to make the necessary arrangements for procuring suitable rooms for the Association as soon as possible, a large number of specimens, books, etc., having already been offered for the museum and library.

ARCHÆOLOGY will be well attended to in northern Europe this year. The "Congress of Archæology and Prehistoric Anthropology" will meet in Stockholm on August 7th, and will continue in session for nine or ten days. The government has asked from the Diet, a grant of 20,000 fr. towards defraying the expenses of the meeting. A magnificent palace has been set apart for the holding of the Congress, and the King and the city will each give grand fêtes. Visitors will be carried over the railroads at half fares, and many excursions will be made. The "Congrès d' archéologie slave" will be held at Kiew from Aug. 14th to Sept 3d. As "Nature" states, the students of prehistoric man will have a good time of it in northern Europe this summer.

THE entomologists and chemists will probably muster in large force at Hartford, in connection with the meeting of the American Association. At the Portland meeting a memorial was presented by the entomologists and endorsed by the Standing Committee, urging the American and Canadian Entomological Societies, to hold annual meetings at the same time and place with the American Association, and they also appointed a committee to bring before the Hartford meeting for discussion, a code of rules for securing uniformity of nomenclature among American Entomologists. The chemists are proposing the celebration of the Centennial of Chemistry and the indications are that the celebration will take place at Hartford, during the week of the Association meeting, though this is not yet officially determined.

Since the publication of our note about the Anderson School of Natural History in the May number, we have learned that in addition to the instructors there named, Dr. W. S. Barnard will give lectures on the Protozoa, Prof. D. S. Jordan will take charge of the department of Marine Botany, and Mr. P. Roetter will give instruction in drawing.

BOOKS RECEIVED.

Memoires de l' Academie Royale de Copenhague. Vol. x, no. 3, 1873. 4to.

Bidrag til Kundskat om Arterne af Slægten Cyamus Latr. eller Hvallusne. Af Chr. Fr. Lutken. Med 4 Tavler.

No. 4. *Almindelige Egenskaber ved Systemer af plane Kurver, med Anvendelse til Bestemmelse af Karakteristikerne i de elementære Systemer af fjerde Orden. Med 5 Tavler.* Af H. G. Zeuthen. 1873.

No. 5. *Thermochemiske Undersogelser.* XII. *Undersogelser over Iltnings og Reductionsmidler.* Ved Julius Thomsen. 1873.

No. 6. *En Sætning om den Eulerske Faktor svarende til Differentialligningen* $M+N\frac{dy}{dx}=0$, *hvor M og N ere algebraiske Funktioner af x og y.* Af P. C. V. Hansen, 1873.

Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College. 4to.

No. VII. *Revision of the Echini.* Part iv. By A. Agassiz. Cambridge, 1874. With plates.

No. VIII. *Echini, Crinoids and Corals.* By Alexander Agassiz and L. F. de Pourtales. Cambridge, 1874. With plates.

Bulletin of the Essex Institute. 8vo. Vol. vi, Nos. 1 and 2. Jan. and Feb., 1874. Salem.

Elemente des Ersten Cometen Vom Jahre 1830, *mit Berucksichtigung von* 319 *Beobachtungen von.* Dr. L. R. Schulze. 8vo. Leipzig, 1873.

Rede in der offentlichen Sitzung der k. Akademie der Wissenschaften am 25. Juli 1873. Zur Vorfeier des Allerhochsten Geburtsfestes Sr. Majestat des Konigs Ludwig II. J. von Dollinger. 4to. Munchen, 1873.

Der Antheil der k. bayerischen Akademie der Wissenschaften an der Entwickelung der Electricitatslehre. Vortrag in der offentlichen Sitzung der k. Akademie der Wissenschaften am 25. Juli 1873. Zur Vorfeier des allerhochsten Geburts-und Namensfestes Sr. Majestat des Konigs Ludwig II, gehalten von W. Beetz ordentl. Mitglied der mathem. physik. Classe 4to. Munchen 1873.

Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger og dets Medlemmers Arbejder i Aaret 1873. Med 2 Tavler og med Bilag samt med en Resume du Bulletin de l'Academie Royale Danoise des Sciences et des Lettres. 8vo., No. 1. Jan.-March. Kjobenhavn.

Sitzungsberichte der philosophisch-philologischen und historischen Classe der k. b. Akademie der Wissenschaften zu Munchen. 8vo., sig. 27, 1871. Heft iv-vi, 1872. Heft i-v, 1873. Heft i, ii. Munchen.

Sitzungsberichte der mathematische-physikalischen Classe der k. b. Akademie der Wissenschaften zu Munchen. 8vo, sig. 15, 1871. Heft iii, 1872. Heft 1-3, 1873. Heft. I, II. Munchen.

Proceedings of the Boston Society of Natural History. 8vo. Vol. xvi, Part ii. June, 1873–Jan. 1874. Boston, 1874.

Report on the Birds of Minnesota. By P. L. Hatch, M.D. 8vo.

Bulletin of the Museum of Comparative Zoology at Harvard College, Cambridge, Mass. 8vo, Vol. iii, No. 9. *Catalogue of the Terrestrial Air-breathing Mollusks of North America.* By W. G. Binney. Cambridge, 1874.

Vol. III, No. 10, 7 plates. *Ophiuridæ and Astrophytidæ, New and Old.* By Theodore Lyman. Cambridge, 1874.

Geological Magazine. New Series. 8vo. Decade ii. Vol. i, Nos. 2, 3. Feb. and March, 1874. London.

Proceedings of the Academy of Natural Sciences of Philadelphia. 8vo, pp. 9-24. 1874.

Bulletin of the Buffalo Society of Natural Sciences. 8vo. Vol. i, No. 4. 1874.

Report of the Entomological Society of the Province of Ontario for 1873. 8vo. Toronto, 1874.

Bulletin de l' Institute National Genevois. 8vo. tome xviii. Geneve, 1873.

Societe Entomologique de Belgique. 8vo, No. 97. 1874.

Berichte uber die Verhandlungen der Koniglich Sachsischen Gesellschaft der Wissenschaften zu Leipzig. Mathematisch-Physische Classe. 8vo. 1868 to 1873 incl. Parts i and ii. Leipzig.

Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871-1872. With plates. By S. F. Baird. U. S. Commission of Fish and Fisheries. Washington, 1873.

Annales de la Societe Malacologique de Belgique. 8vo. Tome vi, vii, 1871-1872. With plates. Bruxelles, 1873.

Proces-Verbaux des Seances de la Societe Malacologique de Belgique. 8vo. Tome ii. Bruxelles, 1873.

THE

AMERICAN NATURALIST.

Vol. VIII. — JULY, 1874. — No. 7.

THE CLASSIFICATION OF THE RHYNCHOPHOROUS COLEOPTERA.*

BY JOHN L. LECONTE, M.D.

At the meeting of the Academy held in Washington, Jan., 1867, I had the honor to offer some remarks† upon the systematic value of the great complex of Coleopterous insects known as Rhynchophora.

It was my intention, as then stated, to follow the memoir just mentioned with another, in which the classification of the Rhynchophora and separation into families should be discussed, in the hope of developing a more satisfactory system of arrangement than had been thus far obtained.

Circumstances have prevented me from following this particular line of investigation to a definite result, until within a short time, though it has frequently occupied my attention for brief intervals. The time, however, has not been altogether lost, for I found that, with each return to the investigation, I obtained an additional, though small insight into the constitution of this complex, which has been the subject of repeated efforts by the most laborious and successful students of entomology in Europe.

---

* Read before the National Academy of Sciences, Washington, April 21, 1874.

† Am. Jour. Science and Arts, xliv, July, 1867.

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

The bases of the classification of the Rhynchophora which have been proposed are briefly these:

I. Schonherr* treated the great mass of these insects (excluding only the Scolytidæ), as constituting a single family, divided as follows: —

A. Antennæ not geniculate; antennal grooves wanting; . ORTHOCERI.
Bruchides, Anthribides, Camarotides, Attelabides, Rhinomacerides, Ithycerides, Apionides, Rhamphides, Brenthides, Cylades, Ulocerides, Oxyrhynchides.
B. Antennæ geniculate; grooves almost always distinct; GONATOCERI.
  a. Rostrum short, deformed, antennæ subterminal; *Brachyrhynchi.*
  *Antennal grooves extending below the eyes; Brachycerides, Entimides, Pachyrhynchides, Brachyderides, Cleonides, Molytides, Byrsopides (the last with the rostrum received in aprosternal excavation).
  **Antennal grooves directed towards the eye;
  Phyllobiides, Cyclomides, Otiorhynchides.
  b. Beak cylindrical, slender, antennæ inserted far behind the tip: Erirhinides, Cholides, Cryptorhynchides, Clonides, Rhynchophorides, Conoderides, Cossonides, Dryophthorides. *Mecorhynchi.*

In the gradual progress of the work this last legion, the Mecorhynchi, were divided into Synmerides, having the front coxæ contiguous, and Apostasimerides, having them distant.

The distinctions between the tribes above mentioned were founded mostly on insignificant and evanescent modifications in the form of the beak and antennæ; so that with the immense mass of genera and species described, it became quite impossible to determine either from the work itself.

II. Although the faults found with this artificial system were neither few nor vaguely expressed, yet it was not until the progress (1863) of his admirable work on the Genera of Coleoptera by my deceased friend Prof. Lacordaire required this immense labor to be done over again, that any attempt was made at a new arrangement; the system of Lacordaire was essentially this:

The series was divided into six families; Curculionidæ, Bruchidæ, Anthribidæ, Brenthidæ, Uloceridæ and Scolytidæ. Of these the Bruchidæ were recognized as having scarcely any relations with the other families, and pertaining rather to the Chrysomelidæ, with which they have since been associated by most authors.

---

* Genera et Species Curculionidum, Paris, 1833-1844.

The Bruchidæ and Anthribidæ were characterized by having a distinct labrum; the Scolytidæ by the compressed and dentate tibiæ, while the Brenthidæ were separated rather by form than by any distinct structural character.

The Curculionidæ were then divided according to the size of the mentum, into

I. Mentum closing the buccal space, and concealing the maxillæ ADELOGNATHI.
  Eyes rounded, prothoracic lobes indistinct, . . *Cyclophthalmes.*
  Eyes large, depressed, transverse, narrowed below, prothoracic lobes well marked, ... *Oxyophthalmes.*
II. Mentum smaller, maxillæ visible . . . . . . PHANEROGNATHI.
  A. Front coxæ contiguous or nearly so, . . . *Synmerides.*
    a. Pygidium covered by the elytra; claws not appendiculate.
  Metasternum short; episterna narrow;
    Gular peduncle wanting:
    Gular peduncle distinct:
  Metasternum long; episterna rather wide:
    Antennæ geniculate:
    Antennæ straight.
    b. Pygidium exposed, *or* claws appendiculate:
  Ventral segments not angulated at the sides:
    " " angulated:
  B. Front coxæ separated by the prosternum, which is frequently channelled for the reception of the beak, . *Apostasimerides.*
    a. Oral organs normal. Club of antennæ annulated; 3d joint of tarsi bilobed.
  Mesothoracic epimera not ascending:
    " " ascending.
    b. Oral organs abnormal; 1st joint of antennal club usually very large, corneous, 3d joint of tarsi rarely bilobed.
  Pygidium exposed.
    " covered by elytra.

Each of these divisions contains several tribes differentiated by characters of smaller importance, and not unfrequently indefinite.

III. The next attempt at a general classification was made by Mr. H. Jekel.* This excellent author recognized with great clearness, and defined with tolerable precision, the following eight principal types among the Rhynchophora: Bruchides, Anthribides, Attelabides, Curculionides, Calandrides, Cossonides, Scolytides and Brenthides. The last cited memoir is occupied chiefly with a further development of the classification of the largest of these, the Curculionides proper, and in it he proceeds to separate as sub-families* Brachycerides, Byrsopides and Amycterides, epigeal forms in which the tarsi are not dilated, and not furnished with brush-like hairs beneath. Having thus isolated them the great mass remaining is divided into

---

* Annales Ent. Soc. France, 1864, p. 537. Ins. Saundersiana, 155 sqq., 1860.

Body dissimilar in form ♂, ♀, narrower in ♂	PLATYGNES.
Beak similar in both sexes	*Homorhines.*
Beak dissimilar	*Heterorhines.*
Body nearly or quite of the same form ♂ ♀:	
Pygidium covered by the elytra, body pollinose or pubescent	ISOGYNES.
Pygidium exposed or covered; body squamose, etc.	METRIOGYNES.
Pygidium covered	*Cryptopyges.*
Pygidium exposed	*Gymnopyges.*

The principal types contained in each of these three grand divisions are then characterized in a very clear manner; but for a proper understanding of this system, a vast improvement on all that preceded, the reader must refer to the original memoir. In developing the arrangement of the tribes represented in our fauna, I shall be largely indebted to the views expressed in this most valuable memoir of Mr. Jekel.

There remain to be mentioned two faunal contributions to the history of this subject:

1. A series of remarks by Mr. Suffrian,† in which the German species of several genera, not before carefully studied, are more fully elucidated, and various criticisms upon Schönherr's system made.‡ The necessity of a more careful study of the tibiæ and tarsi, almost neglected by Schönherr is insisted on, and an arrangement of the German genera in groups upon these characters is given.

2. That most admirable work of Prof. C. G. Thomson,§ to

---

* Mr. Jekel gives to the anomalous groups this subordinate position, rather, as he says "pour ne pas heurter les idées généralement admises," than in accordance with his own views, which would lead him to regard them as I have done, as genuine families.

† Bermerkungen über einige deutsche Rüsselkäfer: Stettin, Ent. Zeitsch. i-ix.

‡ See specially *op. cit.*, 1847, 157.

§ Skandinaviens Coleoptera, vii, Lund, 1865.

which no entomologist ever refers without finding original material by which he can profit; a remarkable instance of the good results to be obtained by a careful and intelligent study of a very limited fauna. The Rhynchophorous series is divided as follows:

Segments of the abdomen immovable, 2d and 3d nearly equal
ISOTOMA.
Bruchidæ, Anthribidæ (including Urodon), Rhinomaceridæ, Attelabidæ.
Abdomen with the 1st and 2d segments connate, the remaining three movable, the 2d usually much longer than the 3d . ANISOTOMA.
Apionidæ, Curculionidæ, Cossonidæ (including Calandra), Tomicidæ.

From a survey of the different schemes of arrangement which have been thus briefly reviewed, it is evident that while the principal types of the Rhynchophorous series, and the main divisions of the great family Curculionidæ have been clearly perceived, the attempts to define these important forms have failed in a greater or less degree, on account of the want of proper subordination in the characters made use of: all of them natural, all of them important, though in a less degree than supposed by the expounder of each particular system.

To supplement the memoirs above referred to, there came in more recent times the beginning of a systematic study of our species of Curculionidæ by Dr. George H. Horn, a careful and conscientious study of the Calandridæ and Cossonidæ and of some Mecorhynch genera of the United States.* In the introductory remarks he observes:—

"One character is mentioned in the following pages that appears to have escaped notice. In most if not all of the genera of *Mecorhynques*, the males have eight and the females seven dorsal abdominal segments. The *Calandrides* and *Cossonides* appear not to possess this character, as also all the *Brachyrhynques* which I have had time to examine."

The value of this original observation of Dr. Horn is very great, but the limitation which he has placed upon it, though correct as regards the Calandride and Cossonide types, is erroneous as regards the Brachyrhyncs, which have the abdominal sexual characters precisely as in the genera in which he first observed them. So too have the Brenthidæ, and all the anomalous sub-families of Curculionidæ in the Jekelian system. It appears therefore that this peculiarity of structure is of much more importance than was supposed by Dr. Horn, and that it must in reality be the defining character for the division of the Rhynchophora into primary series, of more than family value. I therefore prepared a series of dissections of each of the well recognized Rhynchophorous types within my reach, and have come to the conclusion that they may be arranged in three sets, each of which has a corresponding value to the individual series of normal Coleoptera (*e.g.* Adephaga, Clavicornia, Lamellicornia, etc.); and upon subordinate characters (some of which have been already employed in the classifications above mentioned, though in an empirical manner) into families as follows.

---

*Contributions to a Knowledge of the Curculionidæ of the United States. Proc. Am. Philosophical Soc. 1873, 407.

SERIES 1. HAPLOGASTRA.

Abdomen alike in both sexes; dorsal segments 7, coriaceous, with the exception of the 7th which forms the pygidium, and which is small and corneous; ventral segments not prolonged upwards into a sharp edge; elytra without lateral fold on the inner surface, epipleuræ usually distinct, antennæ straight, 11-jointed. Ungues usually bifid or toothed, rarely (Rhinomacer) simple; Front coxæ conical, prominent, prosternum very short in front of the coxæ. The beak varies in length and thickness, but not according to sex, so far as I know: the front coxæ are contiguous, except in one genus of Rhynchitidæ (Pterocolus); the ventral sutures of the abdomen are straight. The mandibles and tibiæ vary in form, and furnish convenient characters for division into families: —

A. Ventral segments nearly equal in length; epipleural indistinct; tibial spurs small; claws simple (always ?). Mandibles simple, flat; labrum distinct . . . . RHINOMACERIDÆ.
B. Ventral segments diminishing in length; epipleuræ distinct; labrum wanting; claws bifid, or appendiculate
Mandibles flat, toothed on each side; tibial spurs small RHYNCHITIDÆ.
Mandibles stout, pincer shaped, tibial spurs large ATTELABIDÆ.

The affinities of this series are in an ascending direction with the rostrated Heteromera (Oedemeridæ and Pythidæ); this is indicated by the softer tissues in Rhinomaceridæ, and certain Rhynchitidæ, and also by the presence of a labrum in the former. In a descending direction the Attelabidæ lead to the true Curculionidæ, and the Rhynchitidæ to the Belidæ, the last family in the third series of Rhynchophora.

The habits of the species of this series are peculiar, and quite different from those of the next series, and indicate as is wisely observed by Lacordaire,* for the care of their progeny, an industry which appears here for the first time in the family. I cannot describe the results of this instinctive or intelligent industry better than by condensing the account of the author just cited, referable however to European species.

1. Rhinomaceridæ. The European species deposits the eggs in the male flowers of *Pinus maritimus*, the development of which is thus prevented. I may be allowed to observe that this synthetic genus, the nearest approach in the Rhynchophora to the lower Heteromera, and therefore the representative of old forms, clings to an old and synthetic type of vegetation.

2. Rhynchitidæ. Some of the species of Rhynchites roll leaves in the manner of the next family. Others deposit their eggs in young fruit, the kernel of which is eaten by the larva; others again place the eggs in the undeveloped buds of trees, which are thus destroyed.

3. Attelabidæ. In the spring the females roll up the leaves of trees, and deposit in each an egg. After emerging from the egg the young larvæ eat the inside layer of the case which covers them, which they probably leave at a later period, when their growth is complete, to perfect their metamorphosis under ground.

These three families are of small extent, and but little need be said regarding their classification.

RHINOMACERIDÆ.

This family is represented in our fauna by two species, one on each slope of the continent, and is easily recognized by the depressed, curved and acute mandibles, and distinct labrum. The pygidium is covered by the elytra, which are punctured without any appearance of striæ. On the inner face there is no trace of a lateral fold: the epipleuræ are indistinct.

ATTELABIDÆ.

Four species of Attelabus on the Atlantic slope are the only representatives thus far known in our fauna. The beak is stouter than in the preceding family, and the mandibles thicker and stronger. The epipleuræ are quite distinct, and there is no trace of a lateral fold on the inner face of the elytra. The pygidium is not covered by the elytra, and is impressed along its upper margin for the reception of the apical edge of the elytra.[*] The tibiæ are armed with large spurs.

---

*Gen. Col. vi, 543.

RHYNCHITIDÆ.

The peculiar form of the mandibles requires the separation of these genera as a distinct family. The teeth on the inner side are well developed as usual, but in addition, the apex is prolonged outwards into an acute process, behind which is another large tooth.[†]

The front coxæ are usually contiguous, large and conical, in one genus (Pterocolus) widely separated. The pygidium is either exposed (Rhynchites, Pterocolus) or covered by the elytra (Eugnamptus, Auletes). The epipleuræ are narrow, but distinct, and on the inner face of the elytra remote from the margin may be seen a short straight fold, the homologue of the well defined fold which limits the lateral groove for the reception of the side margin of the ventral segments observed in all the following families.

SERIES II. ALLOGASTRA.

Abdomen dissimilar in the two sexes; dorsal segments 1–6 coriaceous or membranous, 7th large, corneous, undivided in ♀, divided into two in ♂; ventral segments prolonged upwards forming a sharp edge, fitting into a corresponding groove on the inner face of the elytra, which are without epipleuræ.

The beak and oral organs vary greatly in form, as do also the antennæ, the tarsi, the ungues, and the position of the coxæ; the 1st and 2d ventral segments are most frequently connate, and the 3d is always shorter than the 2d; the 5th is longer than the 4th.

The following families seem to be indicated by the material I have examined :—

A. Antennæ with a solid annulated club:
    a. Tarsi narrow:
        Gular margin very prominent; mentum retracted;

---

[*] Compare in this relation the curious notch in the front part of the pygidium of Anthribidæ, for the reception of the sutural angles of the elytra.

[†] This character was first observed by Thomson, who observes (Sk. Col. vii, 28) concerning his tribe Rhynchitina, "mandibulæ depressæ, extus excisæ, intus dentatæ."

Prosternum not excavated; . . . . . AMYCTERIDÆ.
Prosternum excavated: . . . . BYRSOPIDÆ.
Gular margin not prominent, mentum large, concealing the mandibles, which are not scarred at tip BRACHYCERIDÆ.
b. Tarsi dilated, usually with a brush of hair beneath:
Mandibles with deciduous tip, leaving a scar OTIORHYNCHIDÆ.
Mandibles simple, usually pincer-shaped. . CURCULIONIDÆ.
B. Antennæ with 11 separate joints. . . . BRENTHIDÆ.

Concerning Amycteridæ and Brachyceridæ, but little need be said. They are very peculiar and easily recognized forms, not represented in our fauna.

The first is Australian; the antennæ are slender, and geniculated; the beak short and stout, deeply emarginate at tip, alike in both sexes; the buccal opening is very large, and the cavity is filled almost completely by the mandibles, which are convex, hairy on the greater part of the front surface, deflexed, deeply concave beneath; the gular margin is thickened and prominent, so that a deep cavity is seen between the gula and the mandibles, in which the mentum and oral organs are concealed from view; the eyes are small and nearly round in some, narrowed beneath in others. The front coxæ are contiguous, the prosternum very short; the elytra are connate and extend far over the flanks, so that the side pieces both of the meso- and metathorax are concealed. The dorsal segments of the abdomen are membranous, except the last which is very large, corneous, and convex, more so in ♂ than in ♀, in the former it is truncate behind, exposing a semicircular 8th segment, from under which protrudes (Psalidura) a very powerful and complex genital armature, consisting of a large pair of forceps, conical obtuse, punctured and hairy, under which and seen only from below is a pair of transverse, thin, polished, corneous plates, also meeting on the median line; between them and the forceps is a large deep cavity. The ventral segments are scarcely less singular; the 1st and 2d segments large, flat, connate, united by a sinuate suture; 3d and 4th very short, separated by deeply excavated straight sutures, 5th much larger, in ♂ very deeply and semicircularly excavated, almost to the base, with a tuft of stiff bristles each side at the front edge of the excavation; in the ♀ this segment is flat, and meets the last dorsal at tip in the usual manner; on the sides the lateral upward extension of the 5th ventral is very large, but the spiracle is visible; the extension of the 4th and 3d segments are much smaller, and imbricated upon the 5th and 4th respectively; the side margin of the 1st and 2d is very narrow, and the side pieces of the metasternum are scarcely visible. The elytra are connate, with the lateral groove of the inner face narrow and sharply defined, becoming broader and indefinite at the posterior fourth; on the inner face are seen eight rows of punctures, corresponding to ridges of tubercles on the back. The tarsi are 4-jointed, narrow, or at least the 3d joint not wider than the others, deeply grooved beneath; the tibiæ are truncate, without spurs, the front pair a little incurved at tip in both sexes. Claws simple, not contiguous.

The genera of this family are stated by Mr. Jekel,* to differ by the form of the eyes, some being Cyclophthalmes, others Oxyophthalmes; also in the antennal grooves, some being Obliquiscrobes, others Lateriscrobes. The vestiture of the under surface of the tarsi varies in different genera; in Psalidura they are spongy sericeous beneath, in others ciliate or spinous.

In other genera, the sexual characters are less remarkable than in Psalidura, and will be found to consist chiefly in the division of the last dorsal segment into two, as in the other families of the series.

The Brachyceridæ are restricted to Africa and the neighboring parts of Europe and Asia. They are stout insects, with ventricose elytra, suddenly deflexed behind, and extending far upon the flanks, like the first tribes of Tenebrionidæ, which they also resemble in the large mentum, flat, filling the whole of the buccal cavity. The beak is short and stout, thicker at the extremity, alike in both sexes; the antennal grooves are wanting (Episus); or deep and directed downwards, almost confluent in the gular region (Brachycerus, Microcerus). The antennæ are short, straight or feebly geniculate, scape forming less than $\frac{1}{3}$ the length; joints of the funiculus 7, rather short, club solid, obconical, truncate or subacuminate at tip. Eyes rounded or transverse and acuminate at the lower end. Mandibles stout, short, more prominent in Brachycerus, where they have the lower margin more produced into a cutting edge: the front surface is rough and somewhat angular, but without any trace of the rounded scar seen in Otiorhynchidæ. The scutellum is scarcely visible; the elytra, as above mentioned, are ventricose, irregularly tuberculate or costate, very

---

* Ann. Ent. Soc. France, 1864, 544.

much extended on the flanks, so as to cover the side pieces of the meso- and metathorax; greatly deflexed behind. The lateral groove of the inner face is deep and narrow, becoming wider and obsolete behind. The dorsal segments are membranous, except the last, which is corneous, and divided in ♂ into two as in Curculionidæ. The ventral segments are separated by deep sutures, of which the 1st is sinuate; the 3d and 4th segments are shorter than the others: the lateral extension upwards is narrow; and but slightly wider behind. The front coxæ are contiguous, prominent and subconical, the tibiæ are not dilated, the spurs are small, fixed, projecting inwards, the tarsi 4-jointed, narrow, setose and feebly concave beneath (Brachycerus); pubescent, concave and emarginate beneath (Microcerus); claws large, simple, distant.

BYRSOPIDÆ.

The third of the anomalous families has a more general distribution, and is represented in our fauna by the genus Thecesternus, which forms a separate tribe, distinguished from the other tribes by the prosternal groove for the reception of the beak not extended as far as the front coxæ.

These insects are epigeal, rough and dull colored, with the elytra widely embracing the flanks, but not strongly deflexed behind, concealing the side pieces of the trunk. The beak is very short, not thickened at tip, nor emarginate at the middle; the antennal grooves descend perpendicularly and form a gular constriction: the antennæ are unusually short, imperfectly geniculate, the scape as long as the 1st and 2d joints of the funiculus; the club elongate oval, pointed, distinctly annulated. Eyes transverse, pointed beneath.[*] Mandibles stout, short, front surface curved and roughly punctured; mentum very small, not placed on a gular peduncle; maxillæ exposed. Prothorax widely lobed in front at the sides, so as to conceal the eyes, when the head is deflexed; deeply excavated beneath for the reception of the beak, cavity closed behind in Thecesternus by a triangular plate of the prosternum, but by the front coxæ in the other genera; coxæ small, globose, contiguous. Elytra connate, widely extended on the flanks, declivous behind, rough; lateral groove of inner face

---

[*] Jekel, l. c. 1864, 543, describes the group as being *Adelognathes cyclophthalmes*; Lacordaire (Gen. Col. vi, 293 sqq.) places them in Phanerognathes, and describes the eyes as acuminate below, in which he is correct.

narrow, and well defined; scutellum not visible; humeri in Thecesternus prolonged forwards, so as to extend along the sides of the prothorax. Dorsal segments membranous, last one large, corneous, divided into two in ♂: ventral segments unequal, 1st and 2d very large, more closely connected, suture arcuated: 3d and 4th short, sutures deep, 5th as long as the two preceding; lateral extension moderately wide, wider behind, pygidium articulating with both 4th and 5th ventrals. Legs slender, tibiæ truncate, spurs small, tarsi 4–jointed, narrow, setose beneath.

Several species of Thecesternus are found in the interior regions of the continent, from Illinois to Utah, under dried buffalo excrement, and similar objects.—*To be concluded.*

OBSERVATIONS ON DROSERA FILIFORMIS.

BY WM. M. CANBY.

SOME observations on the power of the insect-trapping "thread leaved sundew" to bend its leaves partly or wholly about its prey, may serve to supplement the interesting notes of Mrs. Mary Treat recorded in the December number of the AMERICAN NATURALIST. They were made about the middle of last August during a day's botanical excursion in the vicinity of "Pleasant Mills," New Jersey, and were suggested by Mr. Darwin in the following memoranda:

(1.) "Put a small atom of crushed fly on a leaf of *Drosera filiformis* near the apex and observe whether the solid leaf itself, after twenty-four hours or so, curls over the fly."

(2.) "Rub roughly with the point of a fine needle half a dozen times a few glands, and observe whether they become inflected after a few minutes, or more probably after a few hours."

The place selected for the experiments was the edge of a cranberry meadow exposed during the whole day to the sun, and yet protected by higher ground and trees from the wind, which otherwise might have prevented successful results by blowing and entangling the leaves together. Hundreds of the plants were here growing, most of their leaves being fully extended, while others were yet unfolding from their circinate vernation. At 7

A.M. bits of the common house fly were placed near the apices of a number of leaves, and these were carefully marked in order to distinguish them from the great number of those which had already captured insects or might during the day make a prey of others. They were not visited again until about 7 P.M., the exigencies of botanical collecting taking my companion and myself several miles away. At another place, however, I had an opportunity to corroborate Mrs. Treat's remark upon the power of the leaves to make prisoners of large flies; for I witnessed the capture of a large and strong dipter,—a desperate struggle ensuing which resulted in the prey being permanently held.

On returning in the evening it was found that in the twelve hours which had elapsed, not only had the glandular hairs around bent towards and touched the atoms of fly, but that also in every case the leaves themselves had bent over them. My sketches, made by laying the leaves upon paper and thus getting their exact outline, show a remarkable uniformity in the amount of inflection; it being in each case between 15° and 20°, mostly about 17°. These experiments were further corroborated by observations upon the leaves around, many of which were much more bent, undoubtedly from having held the prey a longer time. In one case indeed, where the capture had evidently been made near the tip of a fully unrolled leaf, it had again curled round the prey so as completely to encircle it.

So far as the limited time available permitted the observation, I could not perceive that it made much difference in the amount of inflection, upon what part of the circumference of the leaf the prey was taken. But if anything the back or outer side was less sensitive.

As regards the irritation of the glands with a needle the results were entirely negative both in the morning and evening, though it is possible some sensitiveness might have been shown if the experiment had been tried during the noonday heat.

The meagre notes of a traveller made during a single day's observation are of course neither so full nor reliable as might be obtained by one living on the spot and with time at command. I believe further and accurate observations of the habits and functions of this very curious plant would be well repaid by the interesting results obtained.

A KEY TO THE HIGHER ALGÆ OF THE ATLANTIC COAST, BETWEEN NEWFOUNDLAND AND FLORIDA.

BY PROF. D. S. JORDAN.

In the preparation of this Key, the principal work of which use has been made is Prof. W. H. Harvey's Nereis Boreali-Americana. The characters of the higher groups have been to a great extent copied or abridged from that work, and Harvey's Nomenclature and arrangement of families have been generally followed. In several instances, doubtful species have been suppressed or omitted.

Although the number of species recognized by Harvey is much less than has been admitted by previous writers, a still further reduction would be an advantage. Perhaps one-sixth of the species described in the Nereis might with propriety be considered as varieties.

The author has tried to render the Key as simple, compact and easy of comprehension as possible. Obvious characters, wherever available, have been used in preference to technical ones, as the structures on which the classification is really based are microscopic and often hard to ascertain.

Special technical terms are generally avoided, and those not used in Gray's "Manual of Botany" are defined where they occur.

Among plants so little known and which vary so widely as the Algæ, a synoptical table by which any specimen in any condition may be identified, is, of course, impossible, but it is hoped that this Key is sufficiently plain and accurate that nine specimens in every ten may be readily classified by its aid.

SUB-CLASS I. MELANOSPERMEÆ.

(OLIVE-GREEN ALGÆ).

Plants olive-green or olive-brown, never showing tints of red. Fructification monœcious or diœcious. Spores olive-colored, either external or contained singly or in groups in proper conceptacles; each spore enveloped in a pellucid skin, simple or finally separating into two, four or eight sporules. Antheridia, or transparent cells filled with orange-colored, vivacious corpuscles, moving by means of vibratile cilia.

Marine, often of large size, mostly between tide marks, **A**

A. FROND LEATHERY OR MEMBRANACEOUS, FORMING A COMPACT CELLULAR SUBSTANCE, ... **B**

A. FROND OF JOINTED FILAMENTS WHICH ARE EITHER FREE OR UNITED IN A COMPOUND BODY, ... **C**

B. *Spores in spherical cavities in the frond; air vessels commonly present; large, tough plants,* . FUCACEÆ. **D**

B. *Spores in indefinite cloud-like patches on the surface of the frond, which is usually large and stipitate, sometimes deeply divided, but never truly branched,* LAMINARIACEÆ. **F**

B. *Spores attached to external jointed filaments; ours, slender deep water species becoming blackish-green in drying,* . . . . SPOROCHNACEÆ. **E**

B. *Spores in definite groups (sori) on the surface of the frond; fronds smallish, juiceless, the surface netted with small cells,* . . . . . DICTYOTACEÆ. **H**

C. *Spores immersed; fronds not jointed, except in a few small parasites in which the filaments are connected at base,* . . . . CHORDARIACEÆ. **K**

C. *Spores external; fronds either obviously jointed or else surrounded by whorled branchlets,* ECTOCARPACEÆ. **N**

D. Frond leafy; air vessels stalked separate, ... *Sargassum.* **Q**
D. Frond leaf-like below; air vessels in terminal branchlets, pod-like, several celled, ... *Halidrys.* **T**
D. Frond dichotomous; receptacles filled with mucous; air vessels, if present, not as above, ... *Fucus.* **U**
E. Frond slender, with whorls of delicate filaments at the nodes, *Arthocladia.* **X**
E. Frond pinnate, solid, ... *Desmarestia.* **Y**
F. Frond flat, with a midvein, ... **G**
F. Frond flat, without a midvein, ... *Laminaria.* **Z**

F. Frond cylindrical, septate within, ... *Chorda.* e

G. Frond pierced with large roundish holes, ... *Agarum.* d

G. Frond not pierced with holes, ... *Alaria.* c

H. Frond branching, ... J

H. Frond simple, ... I

I. Frond flat, without midvein, ... *Punctaria.* i

I. Frond bag-like, or worm-like, not constricted, . . *Asperococcus.* k

J. Dichotomous, with wide axils, ... *Stilophora.* f

J. Stem mostly excurrent with many long branches, . *Dictyosiphon.* g

J. Frond tubular; branches opposite, tapering to each end, *Striaria.* h

K. Frond cylindrical, branching, ... L

K. Small or minute parasites composed of densely tufted filaments connected at base, free above, ... M

K. Frond tuber-shaped, irregular, ... *Leathesia.* n

L. Axis cartilaginous, dense; filaments of periphery unbranched; long, slender species . . . . *Chordaria.* l

L. Axis gelatinous, lax; peripheral filaments branched. *Mesogloia.* m

M. Tufts on Fucus; ¼ to 1 inch high, ... *Elachista.* o

M. Forming minute brown patches on Ulva, etc., . *Myrionema.* p

N. Frond rigid; each joint of numerous cells, ... O

N. Frond soft; each joint of a single cell, ... P

O. Stems not obviously jointed; branchlets whorled, *Cladostephus.* q

O. Whole frond articulate; pinnately branched, . . *Sphacelaria.* r

P. Frond capillary, much branched, ... *Ectocarpus.* s

P. Frond simple, with clusters of small branchlets, . *Myriotrichia.* x

Q. Air vessels tipped with filiform points. . . . . S

Q. Air vessels nearly or quite pointless. . . . . R

R. Leaves glandular; air vessels not longer than their pedicels. . 1

R. Leaves nearly glandless; pedicels very short. 4

S. Leaves narrow, repand or sub-entire. 2

S. Leaves broader, sharply serrate. 3

T. Frond compressed, repeatedly pinnate. 5

U. Frond flat, with a midrib. V

U. Frond compressed, without a midrib. 6

V. Air vessels usually present; coarse species more common than the next. 7

V. No air vessels; frond serrate. 10

V. No air vessels; margins entire. . . . . W

W. Receptacles obtuse; northern. 8

W. Receptacles acute; river mouths, etc. 9

X. Young stems villous; deep water; rare. 11

Y. Frond cylindrical; branches opposite. 12

Y. Branches flattish, alternate, either with tufts of bright green filaments, or subulate spines. 13

Z. Frond undivided, or cleft only at apex. . . . . a

Z. Frond finally deeply cleft. . . . . b

a. Stipe very long, hollow, largest midway; deep water. 17

a.	Stipe short, cylindrical, solid; margin of frond wavy or ruffled; very large.	14
a.	Stipe flat, winged; frond very long, narrow.	16
a.	Stipe short, flattened; much smaller and more delicate than the preceding huge "oar-weeds" and "tangles."	18
b.	Stipe nearly round, 1 to 6 feet long; common.	15
b.	Stipe flat, 3 to 4 inches long; rare.	19
c.	Frond pinnatifid below, with veinless leaflets.	20
d.	Rocks, etc., below low tide; common N.	21
e.	Frond constricted at intervals, 1 to 2 feet long.	23
e.	Frond not constricted, 1 to 40 feet long.	22
f.	Adhering strongly to paper; rare.	24
g.	On stones, Fucus, Chordaria, etc.; common.	25
h.	Fruit — groups of spores in transverse lines.	26
i.	Frond tapering each way; 1 to 4 lines wide.	27
i.	Frond an inch or more wide.	j
j.	Dark green; attenuate to base.	28
j.	Pale; abruptly tapering to base.	29
k.	Fruit — minute, scattered dot-like sori.	30
l.	Frond with long, filiform, sub-simple branches.	31
l.	Irregularly, mostly dichotomously branched.	32
m.	Slender, with a few short branches; on Zostera.	35
m.	Clumsy with long worm-like branches.	33
m.	Filiform; branches long; branchlets short; axils wide.	34
n.	On Corallina, etc.; tuber size of a walnut or less, becoming finally hollow.	36
o.	Brown pencil-like tufts on the common Fuci.	37
p.	Several species probably here; the commonest is	38
q.	Branches slender; branchlets forked, regularly whorled.	39
q.	Coarser, branchlets simple, irregularly whorled.	40
r.	In globose tufts on small Algæ.	41
r.	In spreading patches on rocks and sand.	42
s.	Branches mostly opposite or in fours.	t
s.	Branches mostly alternate.	u
t.	Propagula (pod-like bodies regarded as the fructification, which are formed by partial or entire transformation of a branch) elliptical, sessile.	48
t.	Propagula forming swellings in the lesser branches.	43
u.	Joints of stem decidedly longer than broad.	w
u.	Joints of stem not longer than broad.	v
v.	Zigzag, much forked; small spine-like branchlets at nearly every joint.	51
v.	Stem excurrent; propagula elliptical; branches erect.	49
v.	Propagula elongated; our commonest Ectocarpus.	44
w.	Propagula linear, tipped with points formed in the ultimate branchlets.	45
w.	Tufts sponge-like, densely interwoven.	46

w. Branches with short, remote, horizontal, spine-like branchlets. **52**
w. Not as above; long, loose and feathery. **50**
x. On Chorda, Dictyosiphon, etc. Stem flexuous. **53**

LIST OF SPECIES.

In the following list the distribution of each plant is given, as far as known. The figures refer to the average height of the plant in inches.

1. **SARGASSUM**[*] **VULGARE** Agardh (*Sea-Lentils*). Cape Cod and South. 12-36.
2. **SARGASSUM MONTAGNEI** Bailey. Rhode Island and South. 12-30.
3. **SARGASSUM BACCIFERUM** Agardh. (*Sea-grapes, Gulf-weed.*) Gulf Stream. 12-40.
4. **SARGASSUM HYSTRIX** Agardh. Gulf Stream. 12-20.
5. **HALIDRYS SILICULOSA** Lyngby. Newfoundland. 10-50.
6. **FUCUS NODOSUS** Linnæus. New York and North. 10-50.
7. **FUCUS VESCICULOSUS** Linnæus. New Jersey and North. 6-30.
8. **FUCUS FURCATUS** Agardh. Newfoundland. 12-20.
9. **FUCUS CERANOIDES** Linnæus. New York. 10-25.
10. **FUCUS SERRATUS** Linnæus. Massachusetts and North. 24-40.
11. **ARTHOCLADIA VILLOSA** Duby. North Carolina. 6-35.
12. **DESMARESTIA VIRIDIS** Lamoroux. New York and North. 12-36.
13. **DESMARESTIA ACULEATA** Lamoroux. New Jersey and North. 12-80.
14. **LAMINARIA SACCHARINA** Lamoroux. (*Venus' Girdle.*) Cape May and N. 12-120.
15. **LAMINARIA DIGITATA** Linnæus (*Oar-weed*). Long Island and North. 40-144.
16. **LAMINARIA LOREA** Bory. Newfoundland. 24-60.
17. **LAMINARIA LONGICRURIS** De la Pylaie. Rhode Island and North. 60-100.
18. **LAMINARIA FASCIA** Agardh. New Jersey and North. 2-12.
19. **LAMINARIA DERMATODEA** De la Pylaie. Newfoundland. 50.
20. **ALARIA ESCULENTA** Greville (*Badderlocks*). Cape Cod and North. 36-250.
21. **AGARUM TURNERI** Postels and Ruprecht (*Sea Colander*). Cape Cod and N. 50-160.
22. **CHORDA FILUM** Stack. (*Lucky Minny's Lines*). Cape May and North. 15-500.
23. **CHORDA LOMENTARIA** Lyngby. Charleston and North. 8-18.
24. **STILOPHORA RHIZODES** Agardh. New Jersey and North. 4-5.
25. **DICTYOSIPHON FŒNICULACEUS**[†] Greville. New Jersey and North. 6-24.
26. **STRIARIA ATTENUATA** Greville. New York. 2-3.
27. **PUNCTARIA TENUISSIMA** Greville. New Jersey and North. 2-10.
28. **PUNCTARIA PLANTAGINEA** Greville. Cape Cod and North. 6-12.
29. **PUNCTARIA LATIFOLIA** Greville. New Jersey and North. 8-12.
30. **ASPEROCOCCUS ECHINATUS** Greville. Massachusetts. 5-24.
31. **CHORDARIA FLAGELLIFORMIS** Agardh. New Jersey and North. 12-24.
32. **CHORDARIA DIVARICATA** Agardh. Long Island and North. 12-30.
33. **MESOGLOIA VERMICULARIS** Agardh. Halifax. 12-18.

---

[*] More than 120 species of Sargassum have been described, many of them being distinguished by indefinite or inconstant characters. Prof. Agassiz, who had given this group some special attention, expressed his decided opinion that our eight or ten American "species" were merely forms or varieties of one and the same plant. Specimens with blended characters of Nos. 1 and 2 are not uncommon.

[†] In the AMERICAN NATURALIST for August, 1873, notice is given of a discovery of mine of a specimen of DICTYOSIPHON FŒNICULACEUS growing on CHORDARIA FLAGELLIFORMIS not as a parasite, but as a branch of the same plant. Unless there was some mistake, either in observation or in identification, this would show, as was believed long ago by Areschoug, that Dictyosiphon is merely an abnormal state of *Chordaria flagelliformis.*

34. MESOGLOIA VIRESCENS Carmichael. Massachusetts and South. 2–12.
35. MESOGLOIA ZOSTERÆ Areschoug. Halifax. 6–8.
36. LEATHESIA TUBERIFORMIS Gray. Whole Coast. ½–1½.
37. ELACHISTA FUCICOLA Fries. Whole Coast. 1 or less.
38. MYRIONEMA STRANGULANS Greville. Coast. One-tenth.
39. CLADOSTEPHUS VERTICILLATUS Agardh. Long Island and North. 3–8.
40. CLADOSTEPHUS SPONGIOSUS Agardh. Long Island and North. 2–5.
41. SPHACELARIA CIRRHOSA Agardh. New York and North. 1–2.
42. SPHACELARIA RADICANS Dillwen. Massachusetts. ½.
43. ECTOCARPUS BRACHIATUS Harvey. Massachusetts and North. 2–4.
44. ECTOCARPUS LITTORALIS Lyngby. Virginia and North. 6–12.
45. ECTOCARPUS SILICULOSUS Lyngby. Whole Coast. 3–6.
46. ECTOCARPUS TOMENTOSUS Lyngby. Massachusetts and North. 2–6.
47. ECTOCARPUS FASCICULATUS Harvey. New Jersey to Massachusetts. 3–6.
48. ECTOCARPUS GRANULOSUS Agardh. Massachusetts. 4–8.
49. ECTOCARPUS DURKEEI Agardh. New Hampshire. ——. 2.
50. ECTOCARPUS MITCHELLÆ Harvey. Nantucket. 2–3.
51. ECTOCARPUS LANDSBURGI Harvey. Nova Scotia. 1–2.
52. ECTOCARPUS HOOPERI Harvey. New York (?). 3–8.
53. MYRIOTRICHIA FILIFORMIS Griffiths. Maine. 1–2.

HUMAN REMAINS IN THE SHELL HEAPS OF THE ST. JOHN'S RIVER, EAST FLORIDA. CANNIBALISM.[*]

BY PROF. J. WYMAN.

AFTER repeated examinations of the more important shell heaps on the St. John's, we have failed to find any evidence that they were used for the burial of the dead, or for any other purpose than dwelling places. Human bones have, however, been discovered in them, from time to time, under peculiar circumstances, and as their presence opens a question of much interest, it will be desirable to describe in detail each of the instances in which they have been detected, especially where the bones have been found in considerable numbers.

1. The first which came under the notice of the writer, was at Old Enterprise, on Lake Monroe, in 1861, a few rods above the high bluff and near the shore of the lake. The deposit of shells where the bones were found is about four feet thick, and has been much washed away by the waves during the great storms. While making an excavation near the roots of a large palmetto tree

---

[*] We are permitted to print this paper in advance from the "Sixth Annual Report of the Peabody Museum of Anthropology," now in press.—EDS.

which had been partially uncovered by the action of the water, human bones were found about two feet below the surface. A foot above them, where a fire had been made, were ashes and large pieces of oak charcoal. The bones were not burned, however, and did not appear to have been connected with the fire in any way. They were broken into pieces a few inches long, just as was the case with the bones of the deer from the same deposit, or from the adjoining bluff, and like them had lost their organic matter, were incrusted with lime, and had become cemented together, so as in all respects to have the appearance of the same age as the bones of the animals associated with them.

The fragments consisted of the head of a femur broken off just below the lesser trochanter, two fragments of the shaft of this bone, one fragment each of the shaft of the tibia, fibula and humerus, a part of a scapula, including the glenoid portion, two metatarsal bones, and one phalanx of a thumb. It is quite probable that there were originally a larger number of pieces and that many had been carried away by the action of the water in its encroachments on the shore.

Two important and more complete discoveries were made in the neighborhood of Blue Spring, though the localities were somewhat over two miles apart.

2. One of these was on the left bank of the creek through which the spring discharges, and about thirty feet from its union with the river. The bones were found about two feet below the surface, embedded in the shells, and represented a large part of the bones of the skeleton. They were nearly all more or less broken, and were scattered about without any definite order. Many fragments of the skull, however, were found near together. Besides the pieces of the cranium, there were fragments of the following bones: viz., the lower jaw, right and left clavicle, right humerus, right and left scapula, ulna of both sides, right radius, right and left femur, right tibia, the two patellæ, upper end of the sternum, one fragment of pelvis, many fragments of ribs and a few bones of hands and feet. The humerus, radius and tibia of the left side were not found.

3. The other collection is from a low oval mound, in the swamp or meadow, two miles in a northerly direction from Blue Spring. Here, again, portions of many parts of the skeleton were present. Notwithstanding careful search beyond the limits where the bones

were discovered, not a single piece of the head was found. Of eleven vertebræ found, all except one (the fifth lumbar) had their arches detached, as if for removing the spinal cord. The right innominate bone was broken into four pieces; of the left only one large, including the acetabulum, and a few small pieces remained. The right femur was broken into three and the left into five pieces; the left radius and left ulna each into three pieces, the left humerus into two, and the head of it was missing. All the bones of the right arm and right leg below the knee were missing. There were many fragments of ribs. The different pieces were scattered about over a surface of four or five square yards and promiscuously mingled. The bones had not been previously disturbed.

Near these remains were found some fragments of a large earthen vessel, apparently capable of holding several gallons, and varying from a half to three-quarters of an inch in thickness. The bones had lost all their organic matter, and when struck against each other have a decided ring.

4. A small collection of human bones was found in a shell field a few hundred feet south of the mouth of the creek at Blue Spring, and near the river. They consisted of fragments of the humerus, tibia, lower jaw, scapula and ulna, broken in the same manner as those just described, and also bones of the hands and feet. As the field in which they were discovered had been ploughed, it is uncertain to what extent the breaking of them may have been accidental. The appearances were the same as in the bones already described. There were no signs of a burial place.

5. Many fragments of an imperfect human skeleton were found in the mound on Huntoon Island, and near Huntoon creek. They were covered with shells to the depth of eighteen inches, and though the place was completely explored, only the following were discovered; viz., fragments of a skull, an imperfect lower jaw, pieces of the right and left thigh bones, a piece of an upper arm bone, some fragments of the forearm and leg, and a few joints of fingers and toes. The bones were all of a diminutive size, evidently those of a dwarf. Basing an estimate on the proportions of the thigh bones to the whole skeleton, the individual is supposed to have been about three feet and a half high. The angles and articular processes of the lower jaw were broken off and the molar teeth had nearly all disappeared during life, and their

alveoli had been absorbed. These facts indicate an individual which was, at the least, adult. Forty feet from the place where these bones were found, a large tree had been overturned, and among the shells carried up by the roots, was found a human ankle bone (an astragalus), but a careful search brought to light nothing else, in this direction, belonging to man.

6. A single fragment of a human upper jaw of the right side, was found in the large shell heap on the same island and near the river buried to the depth of six or seven feet, and could have been deposited there only at the time the mound was built. An upper arm bone, whole, parts of the lower jaw, and a few fragments of other bones, were discovered in the débris at the base of the same mound where it had been undermined, but the precise place from which they had fallen is uncertain.

7. In the remnant of a mound, three-quarters of a mile below Hawkinsville and on the left bank, human bones were found, about a foot deep, in a layer of shells not more than two feet thick. They appeared to be of the same age as the shells in which they were embedded, and were all broken, and much scattered, a proof that they had not been buried. A second deposit was found twenty-five feet from the preceding, the bones were somewhat incrusted with lime, and were more decomposed. There were from the first locality seven fragments of cranium, two of the left humerus, two of the left clavicle, one of the right ulna, one fragment each of the right and left tibia and several small pieces of other bones. The shore where both these sets were found had been undermined and it is probable that many pieces had been washed away.

8. Excavations made on the side of Bartram's Mound near the river, and where it had been undermined, brought to light numerous pieces of human bones all belonging to one skeleton. There were eighteen fragments of cranium, the right half of the lower jaw, the teeth of which had nearly all been lost and their alveoli absorbed, and thirty fragments of other bones including those of a femur, humerus, radius, tibia, fibula, and a patella. All of these appeared to have been covered for a long time, had lost nearly all their organic matter and were incrusted with a thin layer of calcareous deposit. It is quite likely that here too some of the bones originally deposited had been washed away by the river, as the mound at this point had been largely destroyed. In

several instances the cranial bones were broken into small fragments and were irregularly cemented together by the deposit of lime.

9. A large block of consolidated shells split from the front of Osceola Mound left exposed a portion of a human skull. In detaching this, other bones were brought to view and excavations were continued until no further traces could be discovered. The chief part of the bones were removed in a mass of conglomerate and subsequently exposed by chiselling away the matrix, but from which they have not been wholly detached. The organic matter has entirely disappeared and the matrix adheres so firmly to the bones, that it is very difficult to separate it without at the same time breaking off pieces of bony structure.

Of all the human remains we have met with in the shell mounds these last are the most interesting, both on account of their greater age and of their being almost the only ones which can, with any certainty, be referred to the earliest period of the mounds. Osceola mound is one of the series in which pottery is not found, and its materials, as well as the mound as a whole, have undergone great changes.

There are certainly bones from two individuals, mingled. Two thigh bones, which are mates, lie side by side, but in reversed positions, the upper part of one corresponding with the lower of the other. The articular portions are gone. Parts of at least two others were found, one of which was removed nearly whole. Of the other there are two cylindrical portions, one 55 and the other 90^{mm} long. The exposed ends of the shorter one show the interesting fact that the bone had been artificially divided, by cutting a groove around the circumference of the bone and thus weakening it and then breaking the remainder. This is a common method of dividing bones used by Indians. The broken surface and the marks of the cutting instrument are quite obvious. In the longer piece these marks are present but less distinct. As further evidence of the presence of bones from two individuals, may be mentioned the lower ends of two upper arm bones, both from the right side and of different sizes, and both cemented together. There are three tibiæ, two of which are decidedly flattened and belonged to the same individual, the third having more nearly the triangular section, but only slightly flattened.

Besides the above there are fragments of a scapula, pelvis, humerus, radius, tibia, ribs, tarsal and carpal bones and phalanges. There are but few pieces of ribs, and but a single vertebra has been recognized.

The different bones were artificially broken in a few cases only, and contrasted very strongly in this respect with those previously noticed.

We have met with but a single other instance where human bones have shown signs of having been wrought by the aborigines. This was in the coast shell heap at Ipswich, Massachusetts, where Mr. Eliot Cabot discovered a human upper arm bone, which, as shown by the lines and marks on the surface had been ground or scraped. The nature of this instrument found is uncertain, as the end has been broken off. It is preserved in the Peabody Museum.

10. At Huntoon Island, and in the rear of the shell mound on the St. John's, are two conical mounds, and are supposed to be burial mounds, one fifteen and the other twenty-five feet high. Excavations carried to the depth of six feet, but arrested at this depth on account of our inability to get the necessary labor, did not, however, reveal any evidence of burial in either of them. A collection of human bones was obtained from the top of the larger of them at the depth of about a foot below the surface, which in all respects correspond with those previously described. They were scattered over an area of several square yards and belonged to a young individual as shown by the size of the bones and the condition of the epiphyses. Each of the long bones was broken into two or more, and the skull into many, fragments. Pieces were found from all the principal divisions of the skeleton. There can be no doubt that the bones were intentionally broken, as the upper ends of two humeri show precisely similar marks of violence. In each case the bone is broken off an inch below the head, by an instrument which crushed the bone, the fragments of which, flattened down, are retained in opposition, not having been originally completely separated. The bones are all incrusted with a calcareous deposit, which in some cases cements the fragments, an others the smaller bones, as of the hands, together. Their cond tion is similar to that of the bones from Bartram's Mound alread described.

The above are the chief instances of the presence of hum remains in the shell mounds which have fallen under our noti They are not supposed to be the only ones which existed, for t were all but one chance discoveries. In all but a single instance there was nothing to direct attention to one place rather than another in making excavations, and as these were begun at random it is all but certain that many others escaped detection.

It would perhaps be going too far to say that the presence of human bones, under the circumstances above described, amounted to absolute proof of cannibalism. The testimony of eye-witnesses would be the only sure evidence of it. There is, however, nothing with regard to them which is inconsistent with this practice, nor does any other explanation occur to us which accounts for their presence so well.*

If there were any eye-witnesses of cannibalism among the Europeans who explored Florida in the earliest days of its history, they have left no records of the fact. In later times Jonathan Dickenson, a Pennsylvania quaker, who was wrecked on the coast near St. Lucia in 1699, in the narrative of his sufferings, calls the inhabitants cannibals, but nowhere saw human flesh eaten by them. The most direct statement he makes is as follows: "at this town about a twelve-month before a parcel of Dutch men were killed, who having been cast away on the Bohemia (Bahama) Shoals, they, in a flatt which they built, escaped hither and were devoured by these cannibals, as we understand by the Spaniards."† I am indebted to Dr. C. F. Winslow for a statement in the records of Nantucket that Capt. Christopher Hussey "was cast away on the Florida coast and devoured by cannibals." This event was also in the latter part of the seventeenth century.‡

The reasons derived from our own observations for believing that the ancient inhabitants of the St. John's were cannibals may be stated as follows:

---

* A statement by Le Moyne would at first sight seem to suggest another explanation. The natives when first seen by the French had the habit of dismembering the bodies of their slain enemies and carrying off the scalps and limbs as trophies. Plate XVI represents a celebration in which these are hung up on stakes and around which a ceremony is going on. While such a custom might account for the presence of human bones in the shell heaps, it would not for the fragmentary condition in which these are found, nor for the systematic manner in which all the bones of the limbs, as well as of the other parts of the skeleton, are broken up. In addition it may be stated that for reasons we have given elsewhere there is some doubt whether the Indians who built the shell mounds were the same as those found when the Europeans arrived in Florida, and consequently a practice prevailing among the latter might not exist among the former.

† God's Protecting Providence, Man's direct Help and Defence, etc., p. 60, 8vo. London, 1700.

‡ See doings of the Nantucket Historico-genealogical Society, in Nantucket Inquirer and Mirror. Nov. 22, 1873.

1. The bones, an account of which has just been given, were not deposited there at an ordinary burial of a dead body. In this case after the decay of the flesh there would have remained a certain order in the position of the parts of the skeleton, especially in the pelvis, the long bones of the limbs, the vertebral column and the head. The bones would be entire as in other burials. In the cases here described, they were, on the contrary, scattered in a disorderly manner, broken into many fragments, and often some important portions were missing, as the head at one of the mounds near Blue Spring, the bones of an arm and leg at the other, and in other mounds a still larger number of bones. The fractures as well as the disorder in which the bones were found evidently existed at the time they were covered up, as is shown by the condition of the broken ends, which had the same discoloration as the natural surfaces.

2. The bones were broken as in the case of those of edible animals, as the deer, alligator, etc. This would be necessary to reduce the parts to a size corresponding with the vessels in which they were cooked, or suitable for roasting, or even for eating raw.

3. The breaking up of the bones had a certain amount of method; the heads of the humerus and femur were detached as if to avoid the trouble, or from ignorance as to the way, of disarticulating the joints. The shafts of these bones, as also those of the forearm and leg, were regularly broken through the middle. The olecranon process of the ulna, was in some cases detached in the same manner as the corresponding part has been found to be in the deer.

4. There is no evidence that the bones were broken up while lying exposed upon the ground by wild animals, as the wolves and bears. If they were thus broken one might reasonably expect to find the marks of teeth, but after a careful examination of hundreds of pieces they have not been seen in a single instance. As a general rule dogs, and the same is true of wolves, gnaw chiefly the ends of the bones, which are of a soft and spongy texture, leaving the shaft, which is solid and unyielding almost intact, or at any rate to the last. This is the case even with th bones of birds, which are so much smaller. In the bones fro

the mounds the spongy ends show no marks of teeth and are well preserved though detached from the shaft.

The conclusion we have given is strengthened by the fact that cannibalism prevailed largely in both North and South America, and that the natives of America were led to it by the same motives as were those of other parts of the world. In general this practice may be said to commend itself to the savage mind from the following considerations:—

With some it was a matter of choice, depending upon a liking for human flesh as an article of food, as with the Fijians, who had not even the excuse growing out of a scarcity, for food of all kinds existed with them in greatest abundance. With others, and these are by far the most numerous, it was practised as an act of vengeance or triumph over a fallen foe, and with still others it may be said to have been of the nature of a superstitious rite or ceremony, as with the ancient Mexicans, the Miamis, and others. To the above should be added the pressure of extreme hunger, which drives both savage and civilized man to this terrible alternative.

Of starvation nothing need be said, except that it is not improbable that the idea of eating human flesh as ordinary food, may, perhaps, have had its origin in eating it as a necessity. Once tasted and found to be good, as all cannibals aver that it is, under the influence of savage instincts and passions, the conversion of an enemy's flesh into meat to eat would be very natural.

Of course the above motives, excluding the last, may be more or less combined, and a savage by eating his enemy may get his revenge and satisfy his appetite at the same time. Or, as with the New Zealander, who loves human flesh as a choice food, and who also eats it under the superstitious belief that he thus not only incorporates the body of his enemy with his own, but absorbs also his enemy's soul, so that ever after the two are one. To the victors this had an especial significance, for believing in a future state and the presence of his enemy there, if he eats him in this life he makes sure of it that there will be no trouble with him hereafter, for he possesses him body and soul already.

In the cannibalism as practised in the two Americas, one recognizes the same motives and tendencies and often combined with them, in addition, a degree of cruelty to their victims unsurpassed in other parts of the world.

The degraded and brutal inhabitants of Tierra del Fuego, in their fearful struggle for existence, with the elements on the one hand, and savage foes and scarcity of food on the other, would seem to be almost naturally led to the practice of eating human flesh. Capt. Fitzroy has given a sad picture of these poor, wretched creatures, living on the very verge of regions just capable of sustaining life. They habitually eat their prisoners of war, and in severe winters, when snow and ice cut off their usual supply of food, the old women are sacrificed without hesitation. Having choked and smothered them over a dense smoke, they eat them to the last scrap. The life of the dog, however, is spared under these circumstances, as he can render efficient aid in hunting, which the old women cannot.*

Of the prevalence of cannibalism in Guiana, there is evidence from various sources. The histories printed by De Bry † are full of particulars of the manner in which the bodies of victims are prepared, cooked and eaten. Pizarro and his companions, in their first but fruitless attempts to reach Peru from Panama, came suddenly upon an Indian village, when the inhabitants instantly fled leaving human flesh cooking before the fire.‡ We have the authority of Humboldt for its existence on the Orinoco at the time he travelled there.§ Brett found what he was undoubtedly correct in considering the remains of a cannibal feast in an ancient shell heap.|| The Mexicans practised cannibalism on a most extensive scale on certain occasions. A prisoner was delivered to the warrior who had taken him in battle, and by him after being dressed was served at an entertainment of his friends. "This," says Prescott, "was not the coarse repast of famished cannibals, but a banquet teeming with delicious beverages and delicate viands, prepared with art and attended by both sexes, who conducted themselves with all the decorum of civilized life."¶

There were other kinds of victims. As is well known, human sacrifices formed a very important part of the religion of the ancient Mexicans. Their war god was constantly honored with

---

* Voyage of Adventure and Beagle. Vol. ii, pp. 183 and 189.

† See De Bry's narratives — Brazil, Voyage of Joannes Stadius, Hessus, pp. 71, 81, 89, 126 and 127; also voyage of Joannes Lerus, Burgundus, p. 213.

‡ Prescott, History of the Conquest of Peru. London, Bentley. 1854. p. 98.

§ Personal Narrative. Bohn's edition, Vol. ii, pp. 354, 411-415.

|| Rev. J. G. Wood. Uncivilized Races in All Countries of the World. London, 1870. Vol. ii. p. 602.

¶ Prescott, History Conquest Mexico. Philadelphia, 1874. Vol. i, p. 81.

them, and the companions of Cortez saw large piles of the skulls of those who had been sacrificed. On such occasions, after the heart had been cut with an obsidian knife from the living victim, it was offered to the sun and then to the god; the body was thrown down the teocalli and afterwards divided and eaten. The native allies of the Spaniards, in the siege of Mexico, ate the bodies of their dead enemy.[*] In the city of Mexico itself, as the siege was prolonged and food became scarce, the number of victims first sacrificed to propitiate the god of war in hope of relief, then served out as food to the starving people, was very large. These sacrifices were often made in the sight of the Spaniards, who sometimes recognized the lighter skin of their countrymen as they wound their way up to the sacrificial stone to be in turn distributed as food among the besieged.[†]

Of all the American cannibals the Caribs undoubtedly had a stronger love for human flesh than any others, and not only ate their enemies taken in battle as a matter of revenge as well as gratification, but, like the Fijians, even fattened their prisoners for the cook-house that they might make better and more palatable food.[‡] It was also practised among the Iroquois, Algonquins, Mamis and Kickapoos;[§] it existed in Louisiana,[||] Illinois, and on the northwest coast. The most precise narratives we have of this practice are, however, to be found among the 'relations' of the Jesuits who were often eye-witnesses of the feasts of human flesh held by the Iroquois and Algonquin tribes.

One shudders with horror at the prolonged tortures which preceded death and the feast among these savage people. Every device cruelty could suggest was practised. Long before death, sometimes days, torture began. Burning brands were applied to the naked skin, nails were bitten from the fingers, and flesh from the limbs, gashes were cut in the arms and legs and hot brands thrust into them; the scalp was stripped from the head and live coals and hot ashes poured upon the bleeding surface. Women and children joined in these fiendish atrocities, and when at length the victim yielded up his life, his heart, if he were brave, was ripped from his body, cut in pieces, broiled, and given to the young men under the belief that it would increase their courage; they drank his blood, thinking it would make them more wary, and finally his body was divided limb from limb, roasted or thrown into the seething pot, and hands and feet, arms and legs, head and trunk, were all stewed into a horrid mess, and eaten amidst yells, songs and dances.*

---

[*] Ibid., Vol. iii, p. 132.

[†] Ibid., p. 153.

[‡] Peter Martyr. Decade 1, L. I., folio 2, A.

[§] See notes of Hon. Lewis Cass to Ontwa the son of the Forest, a poem by Henry Whiting. New York, 1822, p. 129.

[||] Father Hennepin. Description de la Louisiane, Paris, 1868. pp. 65, 68, 69.

Much more might be added but enough has been said for our purpose, viz: to show that cannibalism being so common in other parts of America, there would be no improbability of its existence in Florida. We have entered more into details than we otherwise should because the subject of American cannibalism has not received the attention it deserves. Mr. Francis Parkman is almost the only one who has taken the trouble to call attention to the documentary evidence which exists bearing upon it, and I am largely indebted to his writings and to himself personally for references to original statements.

THE HISTORY OF THE LOBSTER.

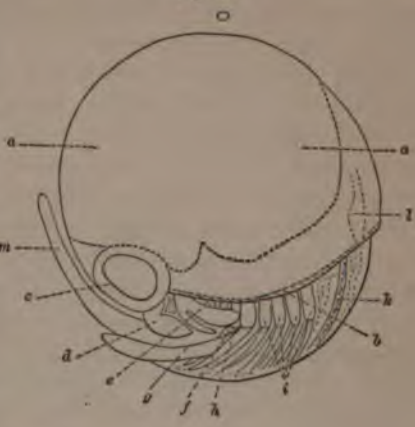
At length we have in a paper by Mr. S. I. Smith, assistant in the Sheffield Scientific School, New Haven, a careful history of the changes undergone by our native lobster, with valuable information on the season of breeding, and other facts of practical interest. The lobster, so important as an article of diet, is dying out from overfishing, and the time may come when it will have to be artificially raised. The information afforded by Mr. Smith is a result of the comprehensive views of Professor Baird, U. S. Commissioner of fisheries, who, besides his own laborious inquiries into the condition and prospects of our fisheries, has called to his aid many naturalists, who have by their special researches, with the aid of the vessels and apparatus afforded by government, thrown much light on the natural history of our fishes and their food.

---

* For a justification of this picture of savagery the reader is referred to La Potherie, Hist. de l' Amerique. Paris, 1722, p. 23. Relation of Barthelemy de Vimout, 1642, p. 46. Relation of Jean Brebeuf, July 1636, p. 121. Relation of Francois Joseph Le Mercier. June, 1637, p. 118. Relation of Vimout, 1644, p. 41.

The following is an abstract (often in the author's own words) of Mr. Smith's paper, which appeared late during 1873, in the Transactions of the Connecticut Academy (vol. ii) and in part in the appendix to the report of the U. S. Fish Commissioner, lately issued. The season at which the female lobsters carry eggs varies much on different parts of the coast. Mr. Smith states that lobsters from New London and Stonington, Conn., are with eggs in April and May, while at Halifax he found them with eggs, in which the embryos were just beginning to develop, early in September. We have seen them in Salem with the embryos ready to hatch in the middle of May, and are told by Mr. J. H. Emerton, that they also breed here in November. It is not impossible that they breed at intervals throughout the year. This is an important point. At any rate there should be a close time on the coast of New England, during April and May, and October and November. Persons should also be fined heavily for selling lobsters with eggs attached.

Fig. 81.



The appearance of the embryo in the egg is represented by fig. 81.* He divides the larval condition of the lobster into three stages. The first, represented on plate 3, figs. A, B (D one of the cephalothoracic legs of the second pair, enlarged 20 diameters; *a*, exopodus; *b*, epipodus; *c*, branchial appendages), is a little under a third of an inch long, and was found early in July at

---

* Embryo, some time before hatching, removed from the external envelope and shown in a side view, enlarged 20 diameters; *a*, *a*, dark green yolk mass still unabsorbed; *b*, lateral margin of the carapax marked with many dendritic spots of red pigment; *c*, eye, *d*, antennula; *e*, antenna; *f*, external maxilliped; *g*, great cheliped which forms the big claw of the adult; *h*, outer swimming branch or exopodus of the same; *i*, the four ambulatory legs with their exopodal branches; *k*, intestine; *l*, heart; *m*, bilobed tail seen edgewise.

Wood's Hole, Mass. In the second stage, the animal has increased in size, and rudimentary appendages have appeared upon the second to the fifth segments of the abdomen.

In the third stage* the animal is about half an inch long, and has begun to lose its Mysis-like (Schizopodal) appearance and to assume some of the features of the adult.

There are probably two succeeding stages before the adult form is attained, one is described by our author, while the first of the two he supposes to have existed, but has not yet discovered. After this the animal ceases to swim on the surface and late in summer seeks the bottom. They feed on the young of various animals, the larvæ of their crustacea, and, when much crowded in captivity, on one another, the stronger devouring the weaker. In the first stage of the adult form when the animal is about three-fifths of an inch long, it still differs from the adult so much that it would be regarded as a distinct genus. "In this stage, the young lobsters swim very rapidly by means of the abdominal legs, and dart backwards, when disturbed with the caudal appendages, frequently jumping out of the water in this way like shrimp which their movements in the water much resemble. They appear to live a large part of the time at the surface, as in the earlier stages, and were often seen swimming about among other surface animals. They were frequently taken from the 8th to the 28th of July, and very likely occur much later." Mr. Smith thinks the young pass through all the stages he describes in the course of a single season. Those in the last stage mentioned he believes had not been hatched from the eggs more than six weeks and very likely a shorter time. How long the young retain their free swimming habit after arriving at the lobster-like form, was not ascertained.

Specimens three inches in length have acquired nearly all the characters of the adult. The description of the different stages are very detailed, and accompanied by admirable figures.

"Of all the larval stages of other genera of crustacea of which I have seen figures or descriptions, there are none which are closely allied to the early stages of the lobster. Astacus, according to Rathke, leaves the egg in a form closely resembling the adult, the

---

*(Pl. 3, fig. *E*, larva enlarged eight diameter. *F*, terminal portion of the abdomen seen from above, enlarged 15 diameters; *a*, one of the small spines of the posterior margin of the terminal segments, enlarged 75 diameters; *G*, basal portion of one of the cephalothoracic legs of the second pair, showing the epipodus and branchial appendages, enlarged 20 diameters.)

PLATE X

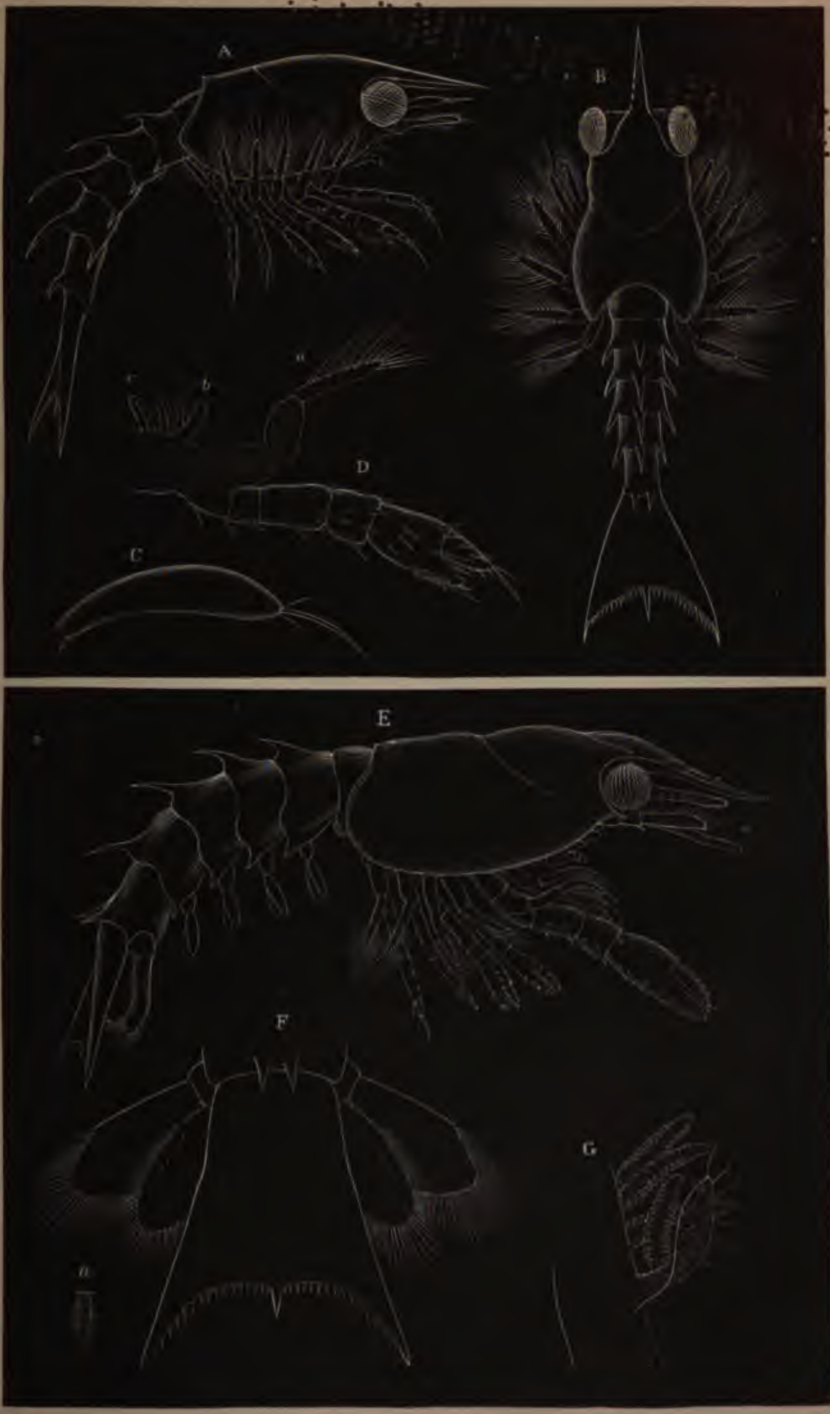
EARLY STAGES [illegible] LOBST

[illegible] and succeeding stages before the adult form [illegible] is described by our author, while the [illegible] of the [illegible] have existed, but has not yet [illegible]. [illegible] appear to swim on the surface and [illegible]. They feed on the young of various animals, [illegible] companions, and, when much crowded in captivity, [illegible] another, the stronger devouring the weaker. In the last stage [illegible] when the animal is about [illegible] it differs from the adult so much that it would be regarded as a distinct genus. "In this stage, the young lobsters [illegible] by means of the abdominal legs, and [illegible] with the caudal appendages, they [illegible] in this way like shrimp which they [illegible] much resemble. They appear to live a longer [illegible] at the surface as in the earlier stages, and [illegible] swimming about among other surface animals. They [illegible] from the 5th to the 28th of July, and [illegible] later." Mr. Smith thinks the young pass [illegible] the stages he describes in the course of a single season. [illegible] last stage mentioned he believes had not been hatching [illegible] than six weeks and very likely a shorter time. [illegible] retain their free swimming habit after [illegible] form, was not ascertained.

[illegible] three inches in length have acquired nearly all the characters of the adult. The description of the different stages are very detailed, and accompanied by admirable figures

"Of all the larval stages of other genera of crustacea of [illegible]

Plate 3.



EARLY STAGES OF THE LOBSTER.

cephalothoracic legs having no exopodal branches and the abdominal legs being already developed. Of the early stages of the numerous other genera of Astacidea and Thalassinidea scarcely anything is known, but as far as is known, none of them appear to approach the larvæ of the lobster. Most of the species of Crangonidæ and Palæmonidæ (among the most typical of macrourans), of which the development is known, are hatched from the egg in the zoëa stage, in which the five posterior pairs of cephalothoracic appendages, or decapodal legs, are wholly wanting, as are also the abdominal legs, while the two anterior pairs of maxillipeds, or all of them, are developed into locomotive organs. In no period of their development do they have all the decapodal legs furnished with natatory exopodal branches. There are undoubtedly larval forms closely allied to those of Homarus in some of the groups of Macrourans, although they appear to be as yet unknown.

"Notwithstanding these larval forms of the lobster seem to have no close affinities with the known larvæ of other genera of macrourans, they do show in many characters a very remarkable and interesting approach to the adult Schizopoda, particularly to the Mysidæ. This appears to me to furnish additional evidence that the Schizopods are only degraded macrourans much more closely allied to the Sergestidæ than to the Squilloidea."

The mode of moulting of the lobster, does not seem to have been observed. We are indebted to Mr. William H. Silsbee for information and specimens regarding that of the adult lobster. He thinks it only moults once a year after having nearly attained its maturity at some period between May and November. On November 8th he saw one moult. It drew its body out of a rent in the carapace, or shell covering the front division of the body. The carapace splits from its hind edge as far as the base of the rostrum, or beak, where it is too solid to separate. The body is drawn out of the anterior part of the carapace. It has been a question how the creature could draw its big claw out through the small basal joints. The claw, soft and fleshy and very watery, is drawn out through the basal joint, without any split in the old crust. In moulting, the stomach, with the cartilaginous masses and bands and œsophagus, is cast off with the old integument. The length of the animal observed before moulting was six and a half inches; immediately after seven and a quarter, a sudden increase in length of three-quarters of an inch.—A. S. P.

REVIEWS AND BOOK NOTICES.

FIELD ORNITHOLOGY.*—So much depends upon accurate and thorough field-work that ornithologists will heartily thank Dr. Coues for his excellent "Manual of Instruction," for it contains just the hints, if followed, to give the highest value to the work of the collector. Poorly prepared skins are unsightly enough, and indeed, a genuine eye-sore in cabinets, but if accompanied by detailed notes of date and locality, with a further record of sex and measurements, they have a far higher scientific value than if in themselves without blemish, but lacked these essential items of information. In this small volume of one hundred and sixteen pages, Dr. Coues has treated the general subject of collecting in a very detailed and highly satisfactory manner, his varied experience in the field, and his knowledge of what constitutes good working material, fitting him eminently for the task he has here attempted. Beginning with the selection and care of guns, ammunition and general equipments, he treats in the following chapters of how, where and when to seek for birds, and of how to handle and carry them when obtained; of note-taking, labelling and measuring, determining sex, etc.; of the preparation of bird-skins, with directions also for mounting; for collecting and preserving nests and eggs, making cabinets, and guarding collections against insect pests, etc. Assuming the reader's total ignorance of the subject, he adopts an easy, familiar style, with here and there a raciness that relieves the tediousness of the details which necessarily go to make up works of this class.

In respect to one point, however, we beg leave to differ from our accomplished author, and that is in respect to *baking skins* to rid them of insect pests. The process is undoubtedly thoroughly efficacious as regards the destruction of the insects, but, what is also of some importance, the baking nearly ruins the skins, rendering them extremely fragile. Bird skins, however, seem to suffer much less by this process than mammal skins, which baking once or twice is usually sufficient to utterly ruin, sometimes causing them to fall almost in pieces of their own weight. The present writer, although having had the care of one of the largest collections of skins in this county for over ten years, has never yet found it necessary to bake a skin to rid it of insects, having accomplished it by other means. Drenching a skin in the best quality of benzine is far preferable to baking, but this is objectionable from its sometimes (generally only after several applications) leaving a sticky residuum on the plumage. A better process is that of thorough fumigation with the bi-sulphide of carbon, which may be accomplished without the offensiveness of the fumes being very apparent by using a tight fumigating box or chest made expressly for this purpose.

---

* Field Ornithology. Comprising a Manual of Instruction for procuring, preparing, and preserving Birds, and a Check List of North American Birds. By Dr. Elliott Coues, U. S. A. Salem: Naturalists' Agency. Boston: Estes & Lauriat. New York: Dodd & Mead, 1874.

The "Check List," though bound with the Manual, is essentially a distinct publication, being also issued separately. It is intended for use in labelling collections, and is hence printed on only one side of the paper. The two together form a supplement to the Key, of which they were originally intended to form a part. The "Check List" is a publication of more importance than to some its name might seem to imply. It is based, the author tells us, on the Key, and "reflects exactly whatever of truth or error that work represents." It differs quite materially from the Smithsonian Check List, published in 1858, as it very naturally should, in order to properly represent the present state of ornithological science in this country. Its greatest modification pertains, perhaps, to the system of nomenclature itself, through the introduction of varietal names. This, the recent advances in American ornithology have rendered imperatively necessary for the proper recognition of the numerous intergrading forms which result from different conditions of environment. But, aside from this, the present list differs from the former in containing much fewer generic names; in embracing some fifty species added to the North American fauna since 1858, and in the exclusion of about 150 of the specific names of the former list, from their being "extralimital, invalid or otherwise untenable," though a large proportion of them still appear in the varietal designations. As already indicated, the "Check List" is a reproduction of the names used in the Key, with, however, the addition of authorities for both the specific and varietal names, including not only the name of the describer of the species or variety, but also the authority for the present association of the names in question. It also includes a number of species and varieties published since the appearance of the Key, the list being brought down to April of the present year. In his preface the author alludes to the "many needless and burdensome generic names," unfortunately adopted in Prof. Baird's great work, "for," he adds, "sanctioned by the usage of such high authority, they have passed current, and are too closely ingrained in our nomenclature to be soon eradicated." This, however, only represents one of the phases through which our science has passed, and which was not wholly without redeeming features, however true it may be that the time has come for us to rid ourselves of such now useless relics. During the publication of the Key, Dr. Coues instituted this needed reform, but too late for its systematic application throughout the class. The land birds were hence left in this respect unchanged, while in the generic names of the waders and swimmers we were carried back again to the days of Audubon, the genera adopted being essentially those of his Synopsis. The publication of the "Check List" seemed to present a favorable opportunity for a similar restriction among the land birds, which our author has failed to improve. It is hence a matter of regret that he has rigidly adhered to the Key, instead of departing from it sufficiently to have given us a consistent system of generic names throughout.—J. A. A.

THE BUTTERFLIES OF NORTH AMERICA.*—The success (in every way but a pecuniary one) of the first series of this admirable work, has led to the publication of a second. This will not be strictly confined to the descriptions and delineations of new species, but the metamorphoses of species before described will be given, a much more important matter than the description and illustration of new species, unless accompanied by life histories. The plates of this new part are thoroughly well doné; a little more attention, however, to the drawing of the larvæ and pupæ would add to the perfect accuracy of the figures devoted to them, though the faults we perceive in one or two cases, *i. e.* an indistinctness of outline of the body and its parts, may be due to the printer. We wish the pages could be numbered, for ease in future reference. The text is lucid and interesting, the plates are not inferior to the best ever published in Europe, and the work is in every way a credit to the country. It is an admirable presentation book, either for young entomologists, or as an attractive serial for the drawing-room table.

---

*The Butterflies of North America, with colored drawings and descriptions. By W. H. Edwards. Second Series, Part I. New York: Hurd and Houghton. May, 1874. 4to, pp. 18 and 5 colored plates. $2.50 a part.

Deep Sea Floridan Polyzoa.[*]—This elaborate treatment of the Polyzoa of the Floridan channel is based on the deep sea dredging made by Count Pourtalés of the U. S. Coast Survey. The geographical distribution of the forms found at the greatest depths in the channel, is of high interest as the assemblage embraced not only well known arctic but also antarctic, and even Australian species, with those purely tropical. The collection affords, as Dr. Smitt states, "new confirmation to the geographical theory first and most clearly stated by Prof. S. Lovén, that the deep sea fauna is a uniform one, connecting the north pole with the south through species of animals distinguished by their strong vital force, and, therefore, also by their great geological age." Several cretaceous, and a number of tertiary (European, Australian and Californian) species are recorded as now living in the Floridan seas.

The Publications of the Buffalo Society of Natural Sciences.[†]—The fourth and last number of the first volume of the "Bulletin" of this society is a capital one if we consider either the number and variety of the papers, the excellence of the illustrations, or the promptness with which the parts are issued. The publication is indeed a great credit to the city of Buffalo, and evinces the interest felt in scientific studies by the citizens. Several entomological papers are contributed by Mr. Grote, the curator of articulates and chairman of the publication committee, by Mr. Scudder, Mr. H. K. Morrison, Dr. L. F. Harvey, and Dr. LeConte; two paleontological articles are prepared by Mr. R. Rathburn and W. H. Pitt. The Contributions to the Geology and Physical Geography of the Lower Amazons, by Prof. C. F. Hartt, is a paper of so much general interest that we shall notice it at length hereafter.

List of North American Noctuid Moths.[‡]—Mr. Grote has before supplied entomologists with a catalogue of our Sphingidæ,

---

[*] Floridan Bryozoa, collected by Count L. F. de Pourtalés. Described by F. A. Smitt. Parts 1, 2, with 18 plates (Transactions of the Royal Swedish Academy of Science) 1872-3.) 4to, pp. 20, 83. Printed in the English language.

[†] Bulletin of the Buffalo Society of Natural Sciences. Buffalo, N. Y. Vol. I. 8vo, pp. 289, with 11 plates and woodcuts. 1873-4.

[‡] List of the Noctuidæ of North America. By Aug. R. Grote, Buffalo, N. Y., May, 1874, 8vo, pp. 77, with colored plate.

Zygænidæ and Bombycidæ, and now we have an admirably prepared list of the next extensive family, the Noctuidæ. No other list has been published since the imperfect one contained in Dr. Morris' Catalogue of our Lepidoptera published by the Smithsonian Institution in 1860.

The species enumerated by Mr. Grote amount to 815, belonging to 282 genera, including the Deltoids (Hypena and allies) which the author, following Lederer, takes out of the Pyralidæ. Though it is not stated in the preface, the list is evidently restricted to that part of the continent north of the West Indies and Mexico. The most important synonyms are given, with an index to the genera. The appendix contains a number of new genera and species, illustrated in part by an excellent plate. The distribution of the genera is given; we wish that the localities of all the species separately could have been added.

BOTANY.

Geographical Distribution of the Cupuliferæ.—This large family, including the chestnuts, oaks, and beeches, since it is the earliest geologically of the dicotyledonous plants, affords much promise of definite conclusions in regard to the genetic relations of the present species from a comparison of the living and fossil forms. The first results of an extended investigation in this direction, by A. S. Orsted, in which the morphology, classification and geographical distribution of the family, are treated has been published in the transactions of the Copenhagen Academy. The conclusions in regard to geographical distribution harmonize with the generally received law, that the more the classification of a family rests on characteristics which indicate a real relationship, the clearer it appears, that each subdivision has its own centre of distribution, and further that the greater the differences of organization between the subdivisions, the greater the geographical distances between these centres. Thus the chestnuts, oaks and beeches, constituting the three groups of this family, afford three principal centres of distribution, and cover three large, widely separated geographical regions; the chestnuts having their centre in the Malay islands, the oaks in Mexico, and the beeches in South America. The chestnut group, which is sharply separated from the other groups, also has its own peculiar, tolerably well defined région, manifesting its greatest diversity of form, and its purest types on the Malay islands, especially on Java and Sumatra, where its proper centre lies. But one species passes its boundaries toward the west, and plays an important part around the Mediterranean, and three species are found in America, whilst the typical genus is found exclusively on the Malay islands, where only a few species of chestnut-oak are found, and not a single true oak. In a similar manner the oak group occurs chiefly in America, north of the equator, forming a second centre of distribution in the mountains of Mexico, where it manifests not only more numerous species but also greater diversity of organization, than anywhere else, several large subdivisions being found that are not met with elsewhere, whilst chestnuts and beeches are entirely wanting. Although the beech group exhibits such a preponderance of species in Chili, that that country must be regarded as its proper home, still the species are so scattered that it is difficult, with the present distribution of land and water, to refer all to a single centre. This difficulty is not so great, however, in regard to *Nothofagus*, which occurs in New Zealand and Van Dieman's Land, since there are other grounds for assuming that these were at one period connected with Chili. Still it seems impossible to refer the species of *Fagus* to the same centre, since the nearest related species is separated by 70° of latitude from the beeches of the south, so that, paradoxical as it may appear, Japan seems once to have formed the connection between the beeches of the north and south, just as we find points of contact between Chili and Japan in other respects. An explanation of this is afforded by the fact that the beeches of Japan conform to those of the Miocene epoch; the centre of distribution of the typical beeches must therefore be sought in a past geological period, and from it they must have been dispersed in different directions, before the present distribution of land and water. Besides the three principal centres alluded to, there are also three secondary centres of distribution characterized by peculiar genera and sub-genera. The principal groups in passing beyond their respective regions, and mingling with each other have produced regions of transition, in which forms appear which are the connecting links between the types from the different centres. Various facts in regard to the distribution of plants in general are also peculiarly illustrated by this family. Thus it exhibits most clearly the marked difference between the floras of Mexico and the Antilles, the oaks being more numerous in Mexico than any other portion of the world, whilst they are wholly wanting in the Antilles, although the latter afford climatic conditions favorable to their growth in many places. This contrast, can be partially explained, as regards the oaks, by the fact that the seeds of the latter soon lose their power of germination, and are not easily transported by currents; and besides the oaks occur in the mountainous regions of Mexico, remote from the sea, and even if the seeds were transported by the aid of rivers, they would not find conditions favorable to their development on the coast of the Antilles, a fact in harmony with the general rule, that the larger number of the plants common to the Antilles and the continent belong to the lowlands of the tropics, whilst the plants of the mountains are generally endemic. The distribution of the cupuliferæ also substantiates, in a remarkable manner, the general rule that the floras richest in endemic species are those where the physical obstructions to diffusion of plants are greatest, the ocean, high snow-covered mountain ranges, especially those with their axes perpendicular to the direction of the wind, forming sharply defined limits of floras. Thus whilst the white oak occurs all over Europe, the species of cupuliferæ in Sumatra and Java are entirely different from each other. In like manner the characteristic cupuliferæ of California are restricted to the western slope of the Nevada chain, and the beeches of Chili are entirely excluded from the east side of the snow-covered Cordilleras. This family also manifests the usual anomalies to the general rule, that the zone of vegetation becomes more elevated near the equator, caused by peculiarities in the form of the mountains, and the influence of clouds, a high plateau, with stronger insolation, producing a considerable elevation of the zone and the snow line, as in Bolivia, and Thibet, whilst abrupt, isolated peaks have a reverse effect. Thus Europe exhibits the influence of plateaus upon the cupuliferæ in two points, namely in the central part of the Alps, in the weaker development and the lowering of the zone of the beeches, whilst the pine and larch, to which a mountainous climate is very favorable, form a broad zone in Wallis and Granbünden, 500 to 1000 feet higher than in the Bavarian Alps. Again the chestnut zone, which reaches 5,000 feet on the Sierra Nevadas, which rest on the plateau of Grenada, does not rise above 3,200 feet in the same latitude, in Portugal. This is owing, it is true, in part to peculiar climatic conditions, which produce an unusual depression of the zones in Portugal, and which also manifest themselves in rendering the zone of vegetation much lower in Sumatra than in Java, on account of the difference in insolation, caused by the more frequent and heavier clouds in Sumatra, where the axis of the mountains is perpendicular to the course of the moist, prevailing winds, whilst in Java it is parallel to it. In this respect Portugal resembles Sumatra, and nowhere are the effects of similar climatic conditions more evident than in the southern portions of Chili, and in Terra del Fuego.

NOTE ON THE INFLUENCE OF LIGHT ON THE DEVELOPMENT OF PLANTS.—Last summer a *Mentychia ornata*, about a fortnight before commencing to bloom, was prostrated by a storm and remained in that position for a week before I restored it to its upright position. The inflorescence of Mentychia is centrifugal, the terminal flower opening first and the rest in their order downward, each flower opening in the evening and closing before sunrise, reopening on a second and usually on a third evening. In this instance the regular order was disturbed, the second flower not opening till after the fourth, then the fifth to the eighth in order, then the twelfth followed by the eleventh, ninth and tenth, then the thirteenth followed by the sixteenth, fourteenth and fifteenth. All the retarded flowers were on the lower side of the prostrate plant, the retardation being the consequence of the diminished exposure to light during one week.—FRED. BRENDEL.

ZOOLOGY.

THE STRUCTURE OF SPONGES.—An exceedingly valuable work on the calcareous sponges has lately been published by Prófessor Haeckel. An increased interest in these organisms has been felt from their frequent occurrence at great depths in the sea, the various dredging expeditions in the north Atlantic and the Mediterranean having revealed many new forms of the silicious, or glass sponges and their allies. Of the animal nature of sponges but few naturalists doubt. Carter, an English microscopist believed that the sponge was an aggregation of Amœba-like infusoria, living among a framework of silicious or limestone spicules. A little later, the lamented Professor H. J. Clark, of this country published, in 1866, a paper in which he maintained that the sponge was an aggregation of flagellate infusoria, like monads of the genera *Monas*, *Anthophysa*, *Codosiga*, etc. The sponge, then, in his view was a compound protozoan animal. Now Haeckel contends that these monads of Clark are simply cells lining the general stomach-cavity of the sponge, each bearing a cilium or thread, and that the sponge is not a compound infusorian, but a much more highly organized animal related to the radiates, such as the Polyps (*Hydra*, etc.). He distinguishes in them a general cavity or stomach, the walls of which consist, as in the Acalephs, of two layers (entoderm and exoderm) of cells. He regards the sponges and Acalephæ as having been evolved from a common ancestor which he terms *Protascus*.

Since writing the foregoing lines we have received a paper by Metschnikoff on the development of a calcareous sponge (*Sycon ciliatum*). He clearly proves that Haeckel's view of the structure of the sponges was correct, but shows that there is no real relationship between the sponges and radiates.

HAECKEL'S EMBRYONAL AND ANCESTRAL FORM OF ALL ANIMALS.—Regarding the sponges, then, as consisting of two layers of cells, surrounding a body cavity, somewhat as in the Hydra, Haeckel compares the sponge to the embryos of the higher animals, both vertebrate and invertebrate. In his view the germ of all animals, and the adult of such a simple form as Hydra, may be reduced to the simple form of the young of a calcareous sponge which he calls *Gastrula*. "The *Gastrula* I consider as the truest and most significant embryonal-form of the animal kingdom." It leads in his view to the sponges, to the Acalephæ, to the worms, to the echinoderms, to the mollusks, and to the vertebrates, through Amphioxus. Embryonal forms which may easily be traced from *Gastrula*, occur among the Arthropods (Crustacea as well as Insects). In all these representatives of different stocks of animals, the *Gastrula* always maintains the same structure. From this identity in form of the Gastrula with the representatives of the different animal stocks (or sub-kingdoms), from the sponges up to the vertebrates, he imagines an unknown stem-form of animals, typified by Gastrula, which he calls *Gastræa*.

TEMPERATURE AND LIFE OF THE ARCTIC OCEAN.—In Prof. Moebius' report on the Zoology of the Second German North-Polar Voyage (translated and abridged in the Annals and Magazine of

Natural History, March) it is stated that so slight are the oscillations of temperature in the polar sea above the parallel of 70°, (ranging between 32° and 36° Fahr.) that the marine animals of Greenland are in just as favorable a position as the animals of the tropical seas, where, as observed by Dana, and others more recently, the temperature of the surface and the bottom at 22 fathoms was identical.

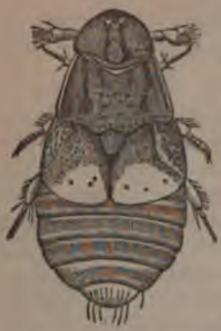
"I suppose that the nearly uniform temperature in which the high northern marine animals live is one of the chief causes of the considerable size by which, according to numerous observations, they are distinguished from individuals of the same species in temperate regions; for at the bottom of the icy sea, species which from their nature can thrive in a low temperature, are but little if at all exposed to those disturbances which the greater oscillations of temperature produce in the vital conditions of the animals of more temperate seas. The organs can consequently perform their functions in a more uniform manner (so far as these are dependent on temperature) than in individuals of the same species which inhabit, for example, the middle and higher regions of the North Sea and the Baltic, where the differences between the lowest and highest temperatures of the water amount to 10°–15° R. (=22°·5–33°·75 F.), or sometimes even more, as has been ascertained by H. A. Meyer, for various points in the western basin of the Baltic, and by myself for two places in the North Sea off the German coast."

A WORM WITH EXTERNAL OVARIES.—In the same paper Prof. Moebius figures and describes a new genus of chætopod worms with external ovaries from the eighteenth segment onwards: they are situated below the branchiæ, and at the boundary between the two segments. Within the body-wall in the same segments are also eggs. The worm is named *Leipoceras uviferum*. It is the only worm known which has external ovaries. In a notice in the same journal it is stated that Moebius has discovered that another worm (*Scolecolepis cirrata* Sars) carries its eggs in pouches like a swallow's nest, along the hinder segments of the body. Many Polychætous worms bear their eggs in sacs attached to the ventral surface of the body (*e. g.*, *Autolycus prolifer* Müll.). One (*Syllis pulligera* Krohn) carries them in the shorter dorsal filaments of its feet, while in *Spirorbis spirillum*, the eggs are carried in folds of the skin, developed in the peduncle of the operculum, with which it closes its tube.

A REMARKABLE BEETLE PARASITE OF THE BEAVER.—Dr. LeConte describes, in the "Proceedings of the Zoological Society of

London," Nov. 5, 1872, a new family of Coleoptera under the term Platypsyllidæ, founded on *Platypsylla castoris* (Fig. 82), made known by Ritsema, who discovered it on specimens of the American beaver in the Zoological gardens of Amsterdam. A little later Prof. Westwood described it under the name of *Platypsyllus castorinus*, a singular coincidence as regards the scientific name. Ritsema regarded it as representing a family of the Aphaniptera, equivalent in value to the *Pulicidæ*, *i. e.*, dipterous. Westwood thought it to be a type of a new order of insects, the *Achreioptera*. Dr. LeConte, and we are fortunate in having in our country one who easily leads the ranks of Coleopterists, after a hasty examination, regarded the insect as coleopterous, a conclusion confirmed by further careful study, the results of which are presented in the beautiful paper before us.

Fig. 82.



Platypsylla castoris.

In this singular insect, the body is long oval, flattened, spiny on the exposed portions, resembling at first sight a minute cockroach, and of the same color. The wing covers are small, not longer than the prothorax, and the head is nearly semicircular, the eyes entirely wanting, the antennæ nine-jointed, clavate; the maxillæ large, with four-jointed palpi; the mentum large, the ligula broad, and the labial palpi short and three-jointed, while the labrum is peculiar. After comparing this beetle with those of other families, the author decides that "the affinities of this insect are very composite, but all in the direction of the Adephagous and Clavicorn series, though chiefly with the latter. The most convenient position of the family will probably be between Hydrophilidæ and Leptinidæ as the families are now arranged, though its tendency to Trichopterygidæ and Corylophidæ is equally strongly manifested. It is therefore a very peculiar and extraordinary synthetic type, which is almost equally in and out of place in any linear arrangement of the series with which it is allied."

As this parasite occurs on our native beaver we hope our naturalists will be on the lookout for specimens, and carefully examine the fur of these animals for that purpose.

TORNARIA NOT A LARVAL STARFISH, BUT THE YOUNG OF A WORM. — Mr. Alexander Agassiz has discovered that the Tornaria, an immature microscopic floating animal, which he in common with other naturalists had thought to be a young starfish, is really a young worm. The parent is a remarkable worm, found at different points on our coast and that of Europe, burrowing in sand, and described by the celebrated Italian zoologist Delle Chiaje. The history of Balanoglossus as given by Agassiz "while showing great analogy between the development of Echinoderms and the Nemertian worms, by no means proves the identity of type of the Echinoderms and Annuloids. It is undoubtedly the strongest case known which could be taken to prove their identity. But when we come carefully to analyze the anatomy of true Echinoderm larvæ, and compare it with that of Tornaria, we find that we leave as wide a gulf as ever between the structure of the Echinoderms and that of the Annuloids." Now the young of certain Echinoderms have a form very similar to larval worms. On this chiefly Prof. Huxley, misled by the names given by J. Müller to some of these larvæ has revived the old opinion of Oken, and associated the Echinoderms with the Articulates; but as he based his opinion entirely upon the figures of Müller, and not upon original investigations, his conclusions, which have been adopted by the majority of English naturalists, do not appear to Mr. Agassiz as tenable. "The hypothetical form to which Huxley reduces these larvæ, to make his comparisons and to draw his inferences, is one which has never been observed, and as far as we now know does not exist." His paper, with many beautiful figures, appears in the "Memoirs of the American Academy of Arts and Sciences."

THE WHITE-NECKED RAVEN. — This bird is seldom seen in the mountains at any period of the year, but during winter it is very common in the vicinity of Denver. As it is rarely molested, it has become so tame that it enters the gardens and streets in the quieter portions of the city and perches on the trees and fences, regarding the passers-by with more curiosity than fear. Like the eastern crow it is social in its habits, going in small parties of two or three up to ten or twenty; and in its general actions and appearance it closely resembles that bird. Its croak is thinner and shriller than that of *C. corax*, which is here seldom, if ever, found. On clear, warm afternoons during winter and early spring, the white-necked raven sometimes ascends to considerable heights, and sails in slow, wide circles somewhat like the buzzard. In summer and fall it is by no means as tame and familiar as during the colder months of the year, and exhibits much of the peculiar cunning of the crow. It breeds in the timber along the stream; during summer I have never observed it in the mountains.

This species probably ranges all along the foot of the Rocky Mountains at least as far north as Wyoming, and extends to a considerable distance eastward over the plains. I have seen it at least a hundred miles east of Denver. I venture to suggest that its range will be found to join that of *C. Americanus* on the east, and that of *C. corax* on the north, being thus the southwestern representative of the genus.—T. MARTIN TRIPPE, *Denver, Col.*

RELATION OF THE CŒLENTERATES AND ECHINODERMS.—At the close of an important paper entitled "Studies on the Development of the Medusæ and Siphonophora" in a late number of Siebold and Kœlliker's Zeitschrift Metschnikoff, a Russian zoologist, thus expresses his views as to the affinities of the Cœlenterates and Echinoderms drawn from a study of the larvæ of the two types.

"In conclusion I will again affirm that I regard the Cœlenterates and Echinoderms as two different types, but which have so many relatives on both sides, that they should always be placed next to each other in the system. I think that between the two there is the same grade of similarity as between the higher worms (Hirudinea, Gephyrea and Annelides) and the Arthropods (Insects and Crustacea). In order to be assured of this, we must observe the bearings of embryological facts, and in regard to the Cœlenterates and Echinoderms not forgot, that the body-cavity and peritoneal cavity represent two different things." This is opposed to the view which Huxley and some German naturalists entertain as to the affinities of the Echinoderms, placing them next to the worms and breaking up the type of radiates (which view is fashionable just at present in Europe;) and confirmatory of the views of those who adhere to the Cuvierian type of Radiates.

NEW CARBONIFEROUS MYRIOPODS FROM NOVA SCOTIA.—It will be remembered that Dr. J. W. Dawson of Montreal discovered the remains of a galley worm or millepede in a stump of Sigillaria, which flourished during the early part of the Coal period of Nova Scotia. It occurred with a land shell, and in the same precious stump occurred the fragments of six-footed insects preserved in the coprolites of the lizards that once ran up and down those trees. The fragments of galley worms were described by Dawson under the name of *Xylobius Sigillariæ*. On subjecting them to farther examination, Mr. Scudder finds there were in reality, portions of three other species of *Xylobius*, and a species of a new genus, which he also thinks should form the type of a new family. It is described in the "Memoirs of the Boston Society of Natural History," under the name of *Archiulus xylobioides*, and the family is called *Archiulidæ*. The insects found with them, but in too small pieces to be recognizable, belonged to the Orthoptera and Neuroptera.

The Discovery of the Origin of the Sting of the Bee.—In Siebold and Kölliker's "Journal of Scientific Zoology" for July, 1872, containing an account of the Proceedings of the Zoological division of the 3rd meeting of the Russian Association of Naturalists, at Kiew, is an abstract of a paper by Ouljanin on the development of the sting of the bee. The author describes but two pairs of imaginal disks, while three were discovered and described by the undersigned in 1866. The author homologizes the elements of the sting with the feet, as had already been done by me in 1871. Soon afterwards Dr. C. Kraepelin published an elaborate article on the structure, mechanism and developmental history of the sting of the bee. In speaking of the origin of the sting (p. 320, vol. 23, 1873), he only refers to Ganin's observations made in vol. 19, of the same journal (1869). Dr. Kraepelin seems to have overlooked the writers' papers* on the origin of the sting of the bee and ovipositor of other insects (Æschna and Agrion) published in 1866 and 1868, the observations and drawings having been made in 1863.—A. S. Packard, Jr.

Deep sea Dredgings in the Gulf of St. Lawrence.—Mr. J. F. Whiteaves records in the March number of the "American

---

* Observations on the Development and Position of the Hymenoptera, with notes on the Morphology of Insects, Proceedings Boston Society N. H., published May, 1866. On the structure of the Ovipositor and Homologous parts in the male Insect. Proceedings Boston Society, N. H. vol. xi, published in 1868. Guide to the Study of Insects, 1869, pp. 14, 536. Embryological Studies on Diplax, Perithemis, and the Thysanurous genus Isotoma, Memoirs Peabody Academy of Science, 1871, p. 20. Here the spring of the Poduridæ is homologized with a pair of blades of the ovipositor of the bee, etc., and the ovipositor regarded as homologous with the spinnerets of spiders and abdominal feet of myriopods.

Journal of Science" the occurrence of the following recent additions to the American fauna, in depths of from 200 to 220 fathoms; of sponges, *Trichostemma hemisphericum* M. Sars, and *Cladorhiza abyssicola* M. Sars, with *Hyalonema longissimum;* of echinoderms, *Ophioscolex glacialis;* of polyzoa, *Flustra abyssicola* G. O. Sars, and *Escharella palmata* Sars; of shells, *Portlandia lucida*, *P. frigida*, *Cylichna umbilicata* and *Cerithiopsis costulata;* of crustacea, *Calocaris MacAndreæ* Bell, *Munidopsis curvirostra*, a new genus and species, allied to *Munida; Pseudomma roseum* G. O. Sars, *Halirages fulvocinctus* Bœck, *Munnopsis typica* Sars, and several other species. Numerous interesting species, many of them new to the American coast, were also dredged in shallower water, on the Orphan and Bradelle Banks, and at the entrance of Gaspé Bay. Among the crustacea from these localities were *Leucon nasicus* Kroyer, *Acanthostephia Malmgreni* Bœck, *Œdiceros lynceus*, and *Aceros phyllonyx* Bœck.

The Mouth Parts of the Dragon Fly.—An important article on the mouth parts of the dragon fly, Perlæ and allied forms (*Orthoptera amphibiotica*), is published by Dr. Gerstaecker, in the memorial volume of the Centennial Celebration of the Society of the Friends of Science in Berlin, 1873. The author describes and figures the palpi of the dragon flies. They possess a one-jointed maxillary palpus, and 2-jointed labial palpus, which are not however in the maxillæ palpiform, but constitute a simple lobe (galea of Burmeister, Erichson and Ratzburg). In Hagen's "Synopsis of Neuroptera of North America" (1861) it is stated "mouth not furnished with palpi." This statement, which is morphologically inexact, was copied in the "Guide to the Study of Insects." It will be corrected in the fifth edition of the latter, as it was unfortunately too late to correct the statement in the fourth edition, now passing through the press, except in a few words in the preface.—A. S. P.

A New Type of Snakes.—I have recently described a snake from the Amazonian region of Peru, in which the spines of the dorsal vertebræ are so dilated at the summit as to present a series of bony plates along the middle line of the back, homologous with the central pieces of the shield of a tortoise. The species presented other peculiarities and was called *Genhosteus prosopis*. It was discovered by Prof. James Orton.—E. D. C.

Notice of a Species of Tern new to the Atlantic Coast of North America.—During the last summer Mr. Franklin Benner of New York, while a member of Prof. Baird's Fish Commission party at Peak's Island, Portland Harbor, Maine, obtained a fine specimen of a species of tern which approaches very near to the characters of the *Sterna longipennis* Nordmann, or *Sterna Pikei* Lawrence, although it differs in several particulars from the descriptions of this species. The specimen was presented by Mr. Benner to the National Museum, in which it is numbered 64,394. It may be described as follows:—

Portland Harbor, Me., July, 1873. Adult, summer plumage?: head, neck, lower part of the rump, upper tail coverts, tail and entire lower parts snow white, the former with a black patch covering the occipital region and surrounding the eye. Mantle, wings, and outer webs of tail feathers pale pearly ash, deeper on the primaries, the outer web of the outer quill and that of the outer tail feathers, dark slate color. Bill and feet, uniform deep black. Wing, 9·60; tail, outer feather, 6·00, middle, 3·40; culmen, 1·15; depth of bill at the base, ·30; tarsus, ·55; middle toe, ·60.

Upon consulting the description of *S. Pikei* Lawr., in the ninth volume of the "Pacific Railroad Reports" (page 863), it will be seen that that species, or at least the type, has a dark-red bill and orange-colored legs. The description of *S. longipennis* Nordmann (in Coues' Key, p. 320), with which Dr. Coues considers *S. Pikei* to be identical, says the bill of that species is "black, or reddish-black, the point often whitish," but makes no mention of the color of the feet. The bird obtained at Portland has both the bill and feet uniform deep black. In view of the fact that it seems to correspond in general dimensions and colors of the plumage with *S. longipennis*, I have concluded to refer it to that species. This bird is in adult summer dress, yet the whole forehead and lores back to the posterior portion of the crown is immaculate white. It is, however, possible that the autumnal plumage was put on prematurely. In the event this bird should prove distinct from *S. longipennis*, I propose for it the name *Sterna Portlandica*.—Robert Ridgway.

The Ruddy Duck.—On the 10th Sept., 1873, I was greatly surprised at finding two immature specimens of *Erismatura rubida* hanging up with a bunch of winter and summer yellow legs in a game stall in Quincy market, Boston. They had been sent from Cape Cod, Mass., the day previous, where they were said to have been shot. They were apparently not more than six weeks old and as their wings were not fledged enough to fly a rod, they undoubtedly must have been hatched in that locality.

This is indeed a very eastern range for this species to have bred, as I believe its usual breeding habitat is in the region of the Rocky Mts. Dr. Elliott Coues writes me "I found the ruddy duck breeding abundantly in July, in ponds on Turtle Mt., exactly on the line of the 49th parallel, between Dakota and the British Possessions, about 150 miles west of Pembina (Red River of the North). I obtained many newly hatched young; eggs were laid in June. This is the only breeding place of this species, of which I am aware by personal investigation."

We have a large migration of this duck through eastern Massachusetts in October and November, which would indicate that they must also breed more directly north of our state, though possibly many may follow the chain of great lakes and St. Lawrence River to the Atlantic states.

I obtained one of the above specimens which I have in my cabinet, and I have no reason to doubt that these birds were taken on Cape Cod.

I have seen specimens, taken as far east as Niagara Falls in May; these were in high breeding plumage, though I did not learn that any nests had ever been found in that locality.—RUTHVEN DEANE, *Cambridge, Mass.*

BIRDS NEW TO THE FAUNA OF NORTH AMERICA.—The Gyrfalcon of Northern Europe and Siberia (*Falco gyrfalco* Linn.) has recently been obtained at Kyska Harbor, one of the western Aleutians, by Mr. W. H. Dall, exploring that region under the auspices of the U. S. Coast Survey. The specimen is an adult female, in perfect plumage, obtained June 30, 1873. On the label are the remarks "eye brown," and "builds." The measurements of this specimen are as follows:—wing, 14·75; tail, 8·00; culmen, ·95; tarsus, 2·30; middle toe, 2·05. The ground color of the upper parts is a very dark blackish plumbeous, the posterior portions, *i. e.*, the rump and upper tail-coverts (and more indistinctly the scapulars and wing-coverts), transversely barred with light bluish plumbeous. The head and neck, however, are entirely uniform plumbeous black, except on the throat. The lower parts are, *everywhere*, including the under surface of the wings, marked with broad transverse bars of plumbeous-black, the two colors about equal in amount; the jugulum, and even the throat, with conspicuous, heavy, drop-shaped longitudinal markings of blackish.

This is the first capture of the Scandinavian, or true, gyrfalcon in North America, and the fact that it breeds in the Aleutians warrants its introduction into the nearctic fauna.

Numenius femoralis Peale must also be added to the number of North American birds, a fine specimen having been obtained May 18, 1869, by Mr. Ferdinand Bischoff, naturalist to the overland telegraph expedition, under the direction of Col. C. S. Bulkley. It is now in the National Museum (No. 58,471 ♂).

This specimen has been compared with Sandwich Island examples, and found to be identical. The species is very different from any other North American one.—ROBERT RIDGWAY.

ON SOME OF THE EVIDENCES OF LIFE IN GREAT SALT LAKE.—Dr. A. S. Packard, Jr., in his interesting remarks on "Insects inhabiting Great Salt Lake and other Saline or Alkaline Lakes in the West," as given in Dr. Hayden's last Report, very properly expresses the hope that some one will make a careful examination of the shores of the lake, and carefully preserve all traces of life which he may find there.

As I examined a portion of the eastern shore of the Great Salt Lake, last year, it may be of advantage to naturalists if I mention some of the evidences of life which I found there. Of course I found the flies, such as are seen by all who visit the lake in summer; the shore was almost literally black with them. They rose before us, but immediately settled down again upon the sands, close to the lake, when we had passed. Their larvæ, in the greatest abundance, were attached to the bottom, and to submerged sticks, close to the shore; and their pupa skins lay in piles on the shore. The little shrimp-like crustaceans (*Artemia fertilis*) were also seen in great profusion, and these were the most numerous, apparently, where the water was the saltest, as in portions partly shut off from the lake.

I collected a large number of shells on the shore of the lake, but did not interpret them as representing life in the lake; they are all, I believe, fresh-water forms. Besides these, I found two fishes, each about a foot long, on the shore of the lake, which without doubt came from the lake itself; but whether they floated there from Lake Utah, or from some one of the rivers that empty into the lake, or whether they belong to Great Salt Lake itself, I do not know. But I have so much faith in finding fishes and other lower forms of life in Great Salt Lake itself, that I shall dredge the lake at my earliest opportunity. I observed water-birds on the lake in great numbers.—SANBORN TENNEY, *Williams College, Nov.*, 1873.

[Prof. Tenney has kindly sent to the Academy, portions of one of the fishes mentioned above, and it proved to be a cyprinoid allied to the western chubs. It is more probable that this lover of pure water was washed into the lake from some tributary and died immediately, than that it was ever an inhabitant of the lake. There is also a possibility of its having been brought by fish-catching birds from a distance. It is known that pelicans and gulls breed on the island in the lake in immense numbers, and that they take long flights for the purpose of securing their food. —F. W. P.]

ENGLISH SPARROWS. — The apprehensions I expressed in my "Key" lest these birds should molest our native species as soon as they overflowed municipal limits has been verified already. Mr. Thomas G. Gentry writes to me:—"The sparrows introduced a few years ago in Germantown, Pa., have become quite common in the adjoining country, and are driving away the robins, bluebirds and sparrows. They increase so rapidly and are so pugnacious, that our smaller native birds are compelled to seek quarters elsewhere." I did not expect the bad news quite so soon. Probably it will not be long before we hear the same complaints from other places. I have always been opposed to the introduction of the birds, mainly on this score, but also for other reasons. There is no occasion for them in this country; the good they do in destroying certain insects has been overrated. I foresee the time when it will be deemed advisable to take measures to get rid of the birds, or at least to check their increase.—ELLIOTT COUES.

A NEW GROUP OF CYPRINIDÆ.—Prof. Cope has recently printed a paper in the "Proceedings of the American Philosophical Society" on the *Plagopterinæ*, a group of cyprinoid fishes characteristic of the hydrographic basin of western Colorado. The group differs from all those related to it in the possession of five osseous spines of the ventral fins, and two closely united osseous spines in the front of the dorsal. In some of the species the remaining dorsal and some pectoral rays are simple and osseous for a large part of their length. In the osseous ventral rays this group resembles the extinct *Saurodontidæ* of the cretaceous period. Three genera were described, viz: *Plagopterus* Cope, with beards and no scales: *Meda* Girard, without either beards or scales; and *Lepidomeda* Cope, with scales and no beards. There are four species, three of which had been brought to light by the naturalists of Lieut. Wheeler's U. S. Survey, west of the 100th meridian.

A HORNED ELOTHERIUM.—At a recent meeting of the American Philosophical Society I exhibited the greater part of the mandible of a large extinct hog of the genus Elotherium which had been described in the "Bulletin of Hayden's Geological Survey of the Territories" as *E. ramosum* Cope. The animal was as large as the Indian rhinoceros, and is peculiar in the possession of two osseous tuberosities on each side, the front pair standing on the chin and projecting into horns of much strength.—E. D. C.

THE SKUNK.—In the "American Journal of Science," for May, the Rev. H. C. Hovey has a very important and interesting article under the title of *Rabies Mephitica*, in which it is shown that the skunk can no longer be regarded as simply a very disagreeable animal, but on the contrary a most dangerous one, and is to be classed with the rattlesnake as an enemy to mankind. As strange as it may appear, Mr. Hovey has brought forward an array of facts to prove that the skunk is very often affected with a disease or perhaps with a natural salivary secretion, that causes its bite to be far more dreaded than that of the rattlesnake or of a mad dog. As the skunk is a nocturnal animal that steals upon his victim without warning and gives the bite which almost invariably proves fatal, it is truly to be dreaded; especially is this the case in the western states where the animal is abundant and many persons are nightly exposed to its attacks. We advise all to read the article and take warning.

THE REDHEADED WOODPECKER IN MAINE (*Melanerpes erythrocephalus* Sw.).—This bird was shot in Orono last summer by a student of the Agricultural College. I have never before seen it in

Maine, and do not find it noticed in any lists of birds given for Maine, to which I have access, except in one published by the Portland Society of Natural History. I do not know from that list who found the bird, or in what part of the state it occurred. The bird may be common in this state but it is new to me in this region.—C. H. FERNALD.

MENOBRANCHUS EDIBLE. — Cayuga Lake (near Ithaca, central New York) abounds with the spotted Proteus, *Menobranchus maculatus* (perhaps a variety of *M. lateralis*, but never striped and always spotted). In preparing a paper upon their anatomy and embryology, Dr. W. S. Barnard and myself have occasion to use them in numbers; and a single fisherman, who sets many hooks for fish has brought us a hundred during the past month (March); he, and all others, apparently regard them as poisonous, and are rather averse to touching them; so far is this from the case, that they are absolutely harmless in every way; and on the 5th, Dr. Barnard and myself eat one which was cooked, and found it excellent; it is our intention to recommend it as food, but not until our investigations are concluded.—BURT G. WILDER.

NEW CRUSTACEA OF THE SWEDISH JOSEPHINE EXPEDITION.— The Norwegian naturalist G. O. Sars, the son of the celebrated zoologist, Professor Michael Sars, has worked up the species of Cumaceæ found by the Josephine expedition. They are little shrimp-like Crustaceans, some of which were found at great depths by the naturalists of the Swedish expedition which participated in the recent deep sea explorations with the dredge. As some of the species new to science are from near the coast of Long Island, the paper will be of interest to our American zoologists. The work is done in the most thorough manner, with admirably executed plates. It forms one of the memoirs of the Swedish Academy.

SPECIAL MODE OF DEVELOPMENT OF CERTAIN BATRACHIANS.— In a letter printed in the "Revue Scientifique," No. 37, 1873, M. Jules Garnier communicates some remarkable observations that have been made by M. Baray on certain Hylodes which exist in large numbers in the island of Guadaloupe. These animals are widely distributed over the island, being found not only near the sea, but in the higher lands of the interior, and after rain their croak makes the air resonant. The physical features of Guadaloupe, a volcanic island, the soil of which is composed of tufa, pozzuolana and similar material, are so peculiar and so very unfavorable for the maintenance of tadpole life, which is essentially piscine, that M. Baray was led to expect the existence of some peculiarities of development. The ova were easily procured, as they were everywhere present under moist leaves. No tadpoles could be discovered, but many of the frogs were of an extraordinarily minute size. The eggs were spherical, with a diameter of from three to four millimetres, and were each provided with a small spheroidal expansion resembling a hernia of the gelatinous mass through a pore in the envelope. In the centre of the sphere the embryo was visible, lying on a vitelline mass of a dirty white color, and having a thin body, a large head and four styliform members with a recurved tail. When the egg was touched the embryo moved rapidly and changed its position. A day later the embryo was perfect, with a tail as long as the body, translucent and like that of a tadpole. The limbs immediately formed, and at the expiration of a few days little frogs of a dark grayish brown color, and *without a vestige of a tail*, escaped from the egg. M. Baray's observations have established the following facts: — 1. That this *Hylodes Martinicensis* commences life by a rotatory movement of the future embryo; 2. The fully formed embryo performs the rotatory movements more rapidly, but in a horizontal plane; 3. The branchiæ make their appearance, and again vanish sometime afterwards; 4. The larva in the ovum is provided with a tail and limbs; 5. The tail of the larva not only facilitates the movements of the imprisoned animal, but also aids respiration by the numerous and minute vessels which ramify in this highly developed appendage; 6. The animal issues from the egg in the form which it preserves throughout life. As M. Garnier observes, these observations seem to constitute a starting-point for a special investigation of great importance, and have a close relation to the question of the adaptability of species to surrounding conditions. It may be asked in this case whether the frog has been created with special modifications adapting it to live in an island destitute of marshes, or has it in course of time acquired a new mode of development enabling it to survive under the exceptional conditions under which it has been placed. — *The Academy.*

THE PALEONTOLOGICAL HISTORY OF TRILOBITES, ETC., AS OPPOSED BY BARRANDE, TO THE EVOLUTION THEORY. — During the year past, another large quarto volume on the trilobites, by M. Barrande, the distinguished paleontologist, has appeared, illustrated with numerous plates. The author strongly opposes, on paleontological grounds, the prevalent evolutional theories. His conclusions we present as briefly as possible; they are of great weight as coming from so experienced and able an observer. He thinks that there is no trace of a gradual improvement of the original type whatever in the entire series of the trilobites. In considering the fossil Crustacea of the earliest Silurian formation of Europe, he regards the coexistence of their principal types, such as the Phyllopodes, and the Ostracodes, with the trilobites of the primordial fauna, so well exhibited in England and Sweden, as constituting an important fact. "Indeed, among the positive facts of paleontology, there are none which would lead us to suppose that forms so contrasted, as we have just indicated, were derived from a common ancestry, by means of filiation or transformation. This descent is thus far a pure creation of the imagination." Again he says, "The great difference of structure which separates the type of trilobites and the types of these two orders (Ostracodes and Phyllopodes) carries us back to a very distant age before the Silurian primordial fauna, if we suppose, according to theory, that they were all derived from a common ancestry. This supposition will oblige us to admit that all the intermediate forms have invariably disappeared in all the countries of the globe, and in a long series of anteprimordial deposits, unknown up to this day." That this inexplicable disappearance, even if accounted for by future discoveries, would only give way to still more formidable facts opposed to evolution, Barrande thinks would be the case; and he goes on to say that the trilobites of the "second fauna" of the Lower Silurian rocks of Bohemia, make their first appearance, accompanied not only by two types of Ostracodes, Primitia and Beyrichia, but also with two types of Cirripedes, or barnacles, perfectly characterized, and which he calls Anatifopsis and Plumulites.

Difficulties such as these rise at each step, he adds, in our paleontological studies, and it has resulted from his work, "that instead of establishing zoological connections, and a gradual transition between the different types of Silurian Crustacea, on the contrary the contrasts in their conformation were not less during those primitive ages, than in those posterior, and that the suddenness of appearance of each of them, with the completeness of their organization, is irreconcilable with the progressive and successive evolution that these theories suppose."

We have been unwilling, with the *Eozoön Canadense* generally received as a proof of the existence of life in the Laurentian period, to believe that the Bohemian strata, investigated so ably by M. Barrande, represent the lowest platform of life.

Mr. Henry Hicks in a recent number (Feb. 5) of "Nature" claims that M. Barrande's list of fossils from the Cambrian formation of England is very incomplete. Instead of there being "no trace of a trilobite" in the Cambrian formation, Mr. Hicks has found sponges, annelides, brachiopods, pteropods, bivalved Crustaceans and trilobites; among the latter a low genus (Microdiscus) with four thoracic segments; the genus has also been found in Canada. It seems best, then, for paleontologists to suspend their judgment, and await the discovery of new facts before pronouncing for or against a primordial fauna more ancient than the Cambrian even. Considering what remarkable intermediate types have been discovered of late in the Rocky Mountains, the advocates of evolution can well afford to wait patiently for a solution of these knotty problems in biology.

MONOGRAPH OF THE WHALE LICE.—A full account of the various species of Cyamus, or so called whale louse, with many figures, has been published in the "Memoirs of the Scientific Society of Copenhagen" by Dr. Lütken. These troublesome crustaceans, allied remotely to the common beach-flea, cling by means of their long claws to the more protected and softer parts of whales, such as the bowhead, the humpbacked, the sperm whales, narwhal and grampus, while they have never been found on the Balænoptera, or fin back whale.

GEOLOGY.

THE CARBONIFEROUS FORMATION OF SOUTH AMERICA.—An examination of the rich brachiopod fauna, collected by Prof. Hartt and his party on his two late expeditions to the Amazonas, from Itaituba, just below the lower falls of the river Tapajos, shows that the carboniferous beds at that place belong to the coal measures.

Associated with a number of new species soon to be described, there are found at that locality, *Spirifera camerata* Morton, *S. apima* Hall, *S. plano-convexa* Shumard, *Ritzia punctulifera* Shumard, and a number of other species characteristic of the North American coal measures.

Mr. Chandless collected carboniferous fossils from the Paranary and Amana, branches of the Mauè-assir, a tributary of the Amazonas between the Tapajos and Madeira. The localities are about one hundred miles west of Itaituba, and the beds and fossils are the same as at that place, as is proved by specimens kindly presented by Mr. Chandless.

A specimen of rock given me by Sr. Gabriel Vierra Lobes of Abydos, and said to have been found on the river Trombetas, contains some of the same species and is interesting since it indicates the occurrence of the same formation on the north side of the Amazonas, where Devonian rocks also occur.

It is interesting to notice in this connection that the Brachiopods described by d' Orbigny, Salter and Zoula from Lake Titicaca, Santa Cruz, and Cochabamba in Bolivia are in great part identical with the Brazilian and North American coal measure forms, and are in all cases more nearly allied to them than to any others.

In a small collection of Peruvian fossils forwarded by Prof. Orton for examination, I have recognized *Ritzia punctulifera* Shumard, and *Spirifera camerata* Morton (*S. Condor* d' Orb.), in a pebble from the bed of the Pichis River, a branch of the Pachitea, one of the western tributaries of the Ucayali. This is a new locality for the carboniferous situated about six degrees north of Lake Titicaca.

Carboniferous beds in the south of Brazil in the provinces of Santa Catharina and Rio Grande do Sul, are described in Prof. Hartt's Geology and Physical Geography of Brazil. These are also of coal measure age, containing workable beds of coal with characteristic coal plants.—O. A. Derby.

Analogy of the Tertiary Fauna of France to the Temperate Regions of America.—MM. Sauvage and Oustalet, in a late meeting of the Société Philomathique of Paris, remarked that all the analogies of the ichthyological and entomological fauna of France during the oligocene (a division of the Tertiary) period were with those of the temperate regions of (North?) America, leading to the opinion that Europe and America were united at this epoch.

On the contrary, considerations drawn from physical geography, and especially the deep sea soundings made by the "Challenger," seem to go against the view of intercontinental bridges held by some naturalists. We look for a solution of the resemblance of the tertiary fauna of Europe and north temperate America, to a study of the tertiary lands of Arctic America, Greenland and Spitzbergen, from which the European forms of an American type may have emigrated in preglacial times.

ANTHROPOLOGY.

THE PYGMIES OF CENTRAL AFRICA.—Dr. Schweinfurth has studied and drawn the Akka or pygmy race of Central Africa, whose average height is four feet six inches. The statements of Herodotus and Aristotle are thus fully confirmed.

MICROSCOPY.

AMPHIPLEURA PELLUCIDA IN DOTS.—A $\frac{1}{50}$ objective was made by Tolles to my order, and finished on the 12th of March, 1873. The angle of aperture as invoiced by Mr. Stodder is 165°. From my measurements I think the objective is correctly named by the maker. At the extreme open point it is a good $\frac{1}{40}$th dry. The screw-collar has twelve divisions: by turning it eight divisions it is adjusted for uncovered wet, and four divisions remain to adjust for cover for immersion work. It works through covering glass of about $\frac{1}{250}$th of an inch, but it is better to use thinner glass, or mica, to enable the observer to focus through specimens.

With lamp-light and the $\frac{1}{50}$th the resolution of *Amphipleura pellucida* is better than I have before seen. Using ordinary daylight, Vibriones, Bacteria, etc., are well defined, especially when a Kelner eye-piece is used as a condenser.

With sunlight and the ammonia-sulphate of copper cell, *Surirella gemma* yields longitudinal striæ, and, as the direction of the light is changed, rows of "hemispherical bosses" as described by Dr. Woodward.

With the same illumination specimens of *Amphipleura pellucida*, mounted dry, by Norman, were resolved and counted with perfect ease and remarkable plainness, the striæ being still distinctly visible with No. 3, eye-piece, draw-tube extended six inches, and power upward of 10,000 times.

It is with hesitation that I remark further that the $\frac{1}{50}$th has resolved the lines of *Amphipleura pellucida* into rows of dots, for the "beaded" structure of the easier test, *Surirella gemma*, is still doubted by some experienced microscopists. But "facts are stubborn things" and the facts are that with Wenham's parabola as an illuminator the dots are seen, and with either the paraboloid or the Amici prism longitudinal lines much finer than the transverse ones are brought out. These lines, which I consider genuine, count not far from 120,000 to the inch. With a slight change of the adjustment their place is occupied by spurious lines counting generally about 60,000 to the inch. The longitudinal lines can only be seen when the focus is best adjusted for the transverse striæ. When the transverse lines are examined, they may be shown smooth and shining, similar to the photograph by Dr. Woodward in the NATURALIST, but much better. If the mirror is then carefully touched a sinuate appearance of the margins of the lines suggestive of beading is seen. This appearance can be brought out readily. And finally after the most painstaking manipulation, and when without doubt the best work is being done, the separated dots or beads appear.—G. W. MOREHOUSE.

ON CIRCULATORY MOVEMENT IN VAUCHERIA.—Prof. Leidy made some remarks on the intra-cellular circulation of plants, as exemplified in the hairs of the mullein, the leaf-cells of Vallisneria, etc. The moving streams of protoplasm he likened to amœboid movements, and expressed the opinion that they were of the same character. In the common alga, Vaucheria, the filaments of which consist of very long cells, comparable to those of Nitella or Chara, he had observed an apparent motion of the cell contents, which is somewhat peculiar and, at least, is not generally mentioned by writers. The wall of the cells is invested on the interior with a layer of tenacious protoplasm, containing the thinner liquid cell contents as usual. The parietal protoplasm is closely paved with green granules, and these appear very slowly but incessantly to change their position in relation with one another. The motion is so slow that it was a question for some time whether it did actually occur, but it appears sufficiently obvious if observed in relation with the lines of a micrometer, and its existence was confirmed by several friends whose attention was directed to it.—*Proceedings Academy of Natural Sciences, Philadelphia.*

NOTES.

We have received the report of the House Committee on Public Lands concerning the geographical and geological surveys west of the Mississippi. The Committee conclude that the "surveys, so far as the same are necessary for military purposes, should be continued; that all other surveys for geographical, geological, topographic and scientific purposes, should be conducted under the Department of the Interior." The Committee also recommended the consolidation of Powell's with Hayden's survey, under the Department of the Interior. This has since been done, and Congress has voted $75,000 for the continuance of Hayden's, and $15,000 for that of Powell's survey. The continuance of Lieut. Wheeler's survey was previously provided for, $30,000 having, we believe, been voted for its expenses. We are glad to see that a step has been taken towards a consolidation of the geological and geographical surveys of the territories of the west. We believe that the scientific interests of the country will be thus furthered, and greater unity, economy and scientific accuracy be secured.

The work should not stop here, and we look forward to a coöperation between the national government and the states in carrying on the survey of the states; in fact, it has partially been begun. This is extremely necessary in the preparation of a general map, geographical and geological, of the United States. More than this, it would be, if we mistake not, a wise and economical measure to unite the work of the Coast Survey and the Signal Bureau with that of the national geographical and geological surveys. When this has been brought about, as it may be thought necessary to do at a future not far distant, all these bureaus might still farther be united under a Science Department, equivalent to the Department of State, of War, the Navy or the Interior, with the officer at the head a member of the Cabinet, to be perhaps appointed by the President under the advice of the heads of the respective bureaus of the Science Department; these bureaus to be those of Physics, Chemistry, Astronomy, Geology and Mining, Meteorology, Geography, Biology and Agriculture, Anthropology and Education, etc., etc.

Such an organization of the scientific forces of the country is already foreshadowed in that of the Smithsonian Institution, which, by its intimate relations with the government, and the national influence it has acquired through the wise and able administration of its affairs, has become even now almost in part the equivalent of a government department.

It is suggested that at the annual meetings of our scientific and learned bodies, some action be taken towards directing public attention to the need of a well organized Department of Science to look after the interests of a broad and generous scientific culture, physical, biological and social, or relating to any other branch of science which may aid in the elevation and improvement of our people.

On June 2d the corner-stone of the American Museum of Natural History, in course of erection on Manhattan Square, New York, was laid in presence of an audience numbering 5000 people. Scientists were invited from various parts of the country. Robert L. Stuart, President of the Museum Association, delivered an address in behalf of the trustees, which was followed by an address by Governor Dix, and one by Professor Joseph Henry. The corner-stone was laid by President Grant. We have seen the plans of this great structure, which is designed to cover eighteen acres, and cost when completed $6,000,000. It will be exceedingly handsome, imposing and convenient. In his address Professor Henry said that the great institution they were inaugurating would not be complete without provision for regular courses of free lectures and the presence of a body of scientific investigators who should give the results of their studies to the country. In congratulating the citizens of New York on the brilliant material prospects of this museum, we indulge the hope that the advice of Prof. Henry may be promptly carried out, and, that the impetus it may, under good management, give towards elevating the culture of our country be commensurate with the amusement it will afford to the people of the great city in which it is located.

We are glad to learn that the value of applied entomology is felt by the people of New York. The Legislature of 1872, as we have recently learned, passed the following resolve:—"The sum of fifteen hundred dollars is hereby appropriated to be paid to Asa Fitch for revising and completing for publication his survey of the noxious and other insects of the state, the state to have the right to publish at all times any number of copies of said work for its own use without further payment. Dr. Fitch's first report was published in 1856; fourteen in all have appeared, being published in the "Transactions of New York State Agricultural Society." No extra copies of the last four reports have been published, and they are exceedingly difficult to obtain. They are interesting, full of fresh observations and deserve the widest circulation.

It appears that for two years the grasshoppers have so devastated several counties in Minnesota and Iowa that the settlers are impoverished, and the earth is now so full of grasshoppers that the soil cannot be tilled for at least one year. A bill was passed by Congress permitting the settlers in all these counties to abandon their land for one year, without prejudice to their rights under the preëmption laws, so that they may support their families elsewhere.

We have before us the first number (May) of "Psyche," the organ of the Cambridge Entomological Club, edited by B. P. Mann (8vo, pp. 4). This timely issue will, besides the matter we may expect to find in such a journal, contain a list of all writings upon entomology published in North America from the beginning of 1874, with a brief note of the contents of each. The subscription price is $1.00.

It is understood that Dr. A. W. Chapman offers his Herbarium for sale. It must be rich in specimens of southern plants, and especially valuable as containing the types of many species described in his "Flora of the Southern United States." His address is Apalachicola, Florida.—W. M. C.

The Botanical Congress of Europe began its sessions under the presidency of Dr. J. D. Hooker at Florence. An interesting report of the meeting will be found in the London Journal of Botany for June and July.

There is a flourishing Natural History Society in New Albany, Indiana, with a fine local collection of Indian remains, some of much rarity. The collections in other departments are very creditable.

The well known entomologist G. A. Herrich Schæffer, died at Ratisbon, Germany, on the 14th of April, aged 75 years.

The distinguished geologist, Professor John Phillips, died at Oxford, England, on the 24th of April, aged 73 years.

Claude Gay, who wrote a large volume on the history, zoology and botany of Chili, recently died, in his seventy-fourth year.

EXCHANGES.

Hair of Dermestes.—Larvæ of *Dermestes* with test-hairs *in situ*, for good microscopic objects.—R. H. Ward, 53 *Fourth Street, Troy, N. Y.*

BOOKS RECEIVED.

Descriptions of New Species of Goniatidæ. With a list of previously described species. By James Hall. 1874. 8vo.

The Science of Homeopathy; or, A Critical and Synthetical Exposition of the Doctrines of the Homeopathic School. By Charles J. Hempel. Cloth, $1.75. Boericke & Tafel. New York, Philadelphia, Baltimore, San Francisco, 1874. pp. 177. 8vo.

The Geological and Natural History Survey of Minnesota. The Second Annual Report, for the Year 1873. By N. H. Winchell and S. F. Peckham. St. Paul, 1874. pp. 75-219. 8vo.

The Organization and Progress of the Anderson School of Natural History at Penikese Island. Report of the Trustees for 1873. Cambridge, 1874. 8vo.

Annual Report of the Trustees of the Museum of Comparative Zoology, at Harvard College, in Cambridge; Together with the Report of the Committee on the Museum, for 1873. Boston, 1874. 8vo.

Urethrotomy, External and Internal Combined, in Cases of Multiple and Difficult Stricture; with Remarks on the Urethral Calibre. By Fessenden N. Otis. New York, 1874. 8vo.

Descriptions of Bryozoa and Corals of the Lower Helderberg Group. By James Hall. Albany, 1874. 8vo.

On the Plagopterinæ and the Ichthyology of Utah. By Edward D. Cope, Philadelphia, 1874. 8vo.

Catalogue of the Coleoptera of Mt. Washington, N. H. By E. P. Austin; *With Descriptions of New Species*, by J. L. LeConte. Boston. 8vo.

Birds of Western and Northwestern Mexico. Based upon Collections made by A. J. Grayson, J. Zantus and Ferd. Bischoff. By George N. Lawrence. Boston. 4to.

Descriptions of Six Supposed New Species of American Birds. By George N. Lawrence. New York. 8vo.

Entomological Contributions. No. III. By J. A. Lintner. Albany. May, 1874. 8vo.

The Butterflies of North America. By W. H. Edwards. Second series, Part I. Published by Hurd & Houghton, New York. May, 1874. 4to.

Catalogue of Flowering Plants of the Southern Peninsula of Michigan, with a few of the Cryptogamia. By N. Coleman. Kent Scientific Institute. Miscellaneous Publications. No. 2. Grand Rapids, 1874. 8vo.

Catalogue of Plants Growing Without Cultivation in the State of New Jersey, with a Specific Description of all the Species of Violet found therein. By Oliver R. Willis. J. W. Schermerhorn & Co., Publishers. New York, 1874. 8vo.

Anatomy of the Invertebrata. By C. Th. V. Siebold. Translated from the German with Additions and Notes by Waldo I. Burnett. James Campbell, Publisher, Boston, 1874. pp. 470. 8vo.

Sixth Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri, made to the State Board of Agriculture, pursuant to an Appropriation for this purpose from the Legislature of the State. By Charles V. Riley. Jefferson City, 1874. 8vo.

Instructions for Observing the Transit of Venus, December 8-9, 1874. Prepared by the Commission authorized by Congress and printed for the use of the observing parties by authority of the Hon. Secretary of the Navy Washington, 1874. 4to.

Geographical and Geological Explorations and Surveys West of the 100*th Meridian.*

Astronomical Report. By Lieut. George M. Wheeler. Washington. 1874. 4to.

On the Transformations of the Common House Fly, with Notes on Allied Forms. By A. S. Packard, jr. 1874. pp. 14. 8vo. With a plate.

Descriptions of New North American Phalænidæ and Phyllopoda. By A. S. Packard, jr. 1874. pp. 18. 8vo.

The Influence of Climate and Topography on our Trees. By J. G. Cooper. 8vo. From the Proceedings of the California Academy of Sciences, March 16, 1874.

The Mezquite Bean. By J. G. Cooper. From the Scientific Press. San Francisco, Nov. 4, 1871. 4to.

Psyche. Organ of the Cambridge Entomological Club. Edited by B. Pickman Mann. Vol. I, No. I. Cambridge, Mass., May, 1874. pp. 4. 8vo.

Observer of Nature. Vol. 1, No. 2. Lawrence, Kansas. Wednesday, April 29, 1874.

Les Cristalloides Complexes a Sommet Etoile. Par Leopold Hugo. Paris, 1872. 8vo.

Essai sur la Geometrie des Cristalloides. Par Leopold Hugo. Paris, 1873. 8vo.

Introduction a la Geometrie Descriptive des Cristalloides. Par Leopold Hugo. Paris, 1874. 8vo.

Y a-t-il des Faunes Naturelles Distinctes a la Surface deu Globe, et quelle Methode doit-on employer pour arriver a les definer et les limiter? Extrait des Annales de la Societe Entomologique de Belgique. Par A. Preudhomme de Borre. 1873. 8vo.

Organ der deutschen Gesellschaft fur Anthropologie Ethnologie and Urgeschichte. Archiv fur Anthropologie. Zeitschrift fur Naturgeschichte and Urgeschichte des Menschen. Von Friedrich Vieweg und Sohn in Braunschweig. 1874. 4to.

Schriften der Naturforschenden Gesellschaft in Danzig. Neue Folge. Vol. 3, Parts 1-2. Danzig, 1872 - 1873. 8vo.

THE

AMERICAN NATURALIST.

Vol. VIII.—AUGUST, 1874.—No. 8.

NOTES ON THE FLORA OF SOUTHERN FLORIDA.

BY FREDERICK BRENDEL.

Is the flora of Southern Florida and the Keys in reality North American or West Indian? One of the greatest authorities in botanical geography, Prof. Grisebach, in his latest work upon the distribution of plants ("Vegetation der Erde," 2, p. 340), as also in a previous one ("Die Geographische Verbreitung der Pflanzen West Indiens," pp. 19 and 20), favors the former opinion.

He says:—"The character of the vegetation of Florida is in general identical with that of Georgia and Carolina. But eight species of West Indian woody plants occur in Florida, and but six in Key West.* When the Northern Bahamas above 27° N. Latitude shall be explored it is probable that the difference between them and the neighboring main-land, but sixty-five English miles distant, will be yet more evident. This difference is not due to climate, nor yet to geological structure, for as the coast of Florida is surrounded by coral reefs, so has the archipelago of the Bahamas been built up by the same means. Why is it then that the vegetation of the West Indies has possession of these islands and not of the equally near and similarly formed Keys of Florida? Even the few plants which are common to both occur also for the most

---

*In Florida, two *Coccolobæ*, *Pithecolobium Unguiscati*, *Guettardia elliptica*, *Psychobria lanceolata*, *Myrsine læta*, *Jacquinia armillaris* and *Tournefortia gnapalodes*; in Key West, *Guaiacum sanctum*, *Schæfferia frutescens*, *Passiflora angustifolia*, *Exostemma Caribæum*, *Erithalis fruticosa* and *Beurreria tomentosa*.

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

part on the continental coast of the Gulf, and may as probably have reached the Keys from there as from Cuba. The most obvious reason is found in the fact that the Bahamas are united with the Greater Antilles by innumerable islands and shoals, while on the contrary Florida and the Keys are separated from them by the Gulf Stream—a proof that ocean currents do not always serve to connect floral regions but at times aid in preserving the limits between creations originally distinct." Now to these suggestions some objections may be made. When we see the habitat of many hundred of species indicated in the books by the phrases "New England to Florida," "S. Carolina to Florida," etc., it seems evident that the flora of Florida belongs to that of North America. But "Florida" in most of these cases means Northern Florida. Southern Florida, from Tampa Bay southward, has been explored only at solitary points upon the coast by a few botanists, who have taken notice only of the more conspicuous and chiefly woody plants. It is not improbable that when the vegetation of this region is better known it will prove to be not so different from that of the Northern Bahamas as Prof. Grisebach now supposes.

Geological causes cannot be excluded in botanico-geographical investigations where recent causes are insufficient to explain facts. The coral formation of Southern Florida—if it be true that the polyps cannot live but in a certain depth of water—indicates a slow subsidence of the land, and this movement may possibly have preceded the upraising of the tertiary Atlantic and Gulf coast of the Southern States and the existence of the Gulf Stream. Between Bemini Point and Cape Florida the depth of the stream is considerably less than at any other point, and this may have been the line of connection between Florida and a tropical territory eastward, of which the Bahamas are the remnants. It is no more probable that the "few" woody plants enumerated by Grisebach have immigrated across the channel or made the long circuit of the shores of the Gulf, than that they are the residue of a once larger number of plants common to Florida and the Bahamas.

But is the number of these plants indeed so small? Dr. Chapman enumerates in his "Flora of the Southern States" no less than 231 species which do not extend northward of Tampa Bay. To these 16 may be added from other sources,[*] making 247 species

---

[*] From DeCandolle's Prodromus, *Hyptis spicata*, *Croton humilis* and *linearis*, *Argyrothamnia Fendleri*, and *Zamia Floridana* and *pumila*; from Bot. Mex. Bound. Survey,

(136 woody, 83 perennial, and 28 monocarpic), of which 187 are common to the West Indian Islands and partly to South America and (31) to Mexico, 23 to Mexico only, and 37 known as yet only from Southern Florida.

If it be conceded that the Gulf Stream is an insurmountable obstacle to immediate immigration from the West Indies, and that any plant from there must have made the circuit of the Gulf, why is it that the majority of these emigrants have not settled in Mexico, as should have been expected from the greater chances that evidently exist in favor of that country. The inference is reasonable that the 156 species of Southern Florida which are common only to regions lying southward and not to Mexico have for the most part not been transmitted by the waters of the Gulf, and that we must recur to other than the recent means of migration.

The flora of Northern Florida, including 58 widely distributed species which are not expressly noted by Chapman as growing there, comprises 1511 species of vascular plants, of which 875 occur in the Northern States. Of the remainder 234 extend to North Carolina, 113 to South Carolina, 108 to Georgia, 3 to Tennessee, and 53 only westward. Of all these only 15 are mentioned expressly as occurring in Southern Florida. Of the 125 which are known only from Florida 9 have been found in the southern part of the State. There are 1487 Floridan species which are not known as belonging to Southern Florida, or which at least are not so reported in published documents.

It may further be remarked that the above 247 southern species belong to 170 genera, of which 102 with 131 species are not represented in Northern Florida, and of these again 26 genera with 30 species belong to orders which are not found in other parts of the eastern United States. Comparing, moreover, the woody, perennial and monocarpic species, we find the numbers quite disproportionate and must suspect that a great number of perennials, particularly Cyperaceæ and grasses in the interior are unknown.

From all these facts we conclude that the flora of Southern Florida is, so far as known, not to be considered a part of the

---

Heliotropium polystachyum and *Sarcostemma clausum*; from Nuttall's Sylva, *Acacia latisiliqua*, *Sideroxylon fœtidissimum*, *Cordia speciosa* and *floribunda*, and *Coccoloba parvifolia*; and from Grisebach, *Abutilon permolle*, *Desmodium tortuosum* and *Crinum Floridanum* (?).

North American flora, but a link between it and that of the West Indies, and that a portion of those species which are peculiar to the northern portions of the State, and the immediately adjacent region, may have been derived from the south.

THE CLASSIFICATION OF THE RHYNCHOPHOROUS COLEOPTERA.

BY JOHN L. LECONTE, M.D.

OTIORHYNCHIDÆ.

In a large number of genera* of Rhynchophora, at the front part of the mandibles, may be seen a round or oval depression, having the appearance of a scar, and which served, during the pupa stage, and for the early part of the imago life, as an attachment for a deciduous piece, of a conical and usually slender form. Many times specimens had occurred in which one or both of these pieces were still adherent, and the explanations thereof were varied and incorrect.† The opinion of Lacordaire seems to be quite satisfactory, that they are probably of service in enabling the insect to cut its way out from the nest or cell in which the transformation takes place.

While recognizing the frequent occurrence of this singular structure, altogether without parallel among other insects, it does not seem to have occurred to Lacordaire, that we have here a character of great importance for systematic purpose, and that after removing the large mass of such genera, the normal series of Curculionidæ would be much more amenable to classification. In fact I think it may be shown that the confusion and indefiniteness of the first part of the classification of Lacordaire is mainly owing to the intercalation of genera with scarred mandibles and those with simple mandibles. I have therefore placed the former as a separate family, having the following general characters.

The body affects two forms; in the apterous species the elytra are connate and convex with the humeri rounded; in the winged species they are more oblong, with the humeri more or less prom-

---

* Lacordaire, Gen. Col. vi, 5 (note).

† Müller, Germar's Mag. iii, 124.

inent. The beak is alike in both sexes, usually short and broad, sometimes longer and thickened or dilated at tip, which is emarginate; the antennal grooves are either (1) on the upper surface of the beak (Otiorhynchus), in which case they are short, and not bent downwards; (2) longer, lateral, and directed towards the eyes or (3) long or short, directed obliquely below the eyes; they always extend nearly to the apex. The mandibles are short and thick, pincer-shaped, with an apical scar, which varies somewhat in different genera, to which was attached a deciduous piece also of variable form; very long and falcate (Phyllobius, etc.), long and straight (Trigonoscuta), or short and obtuse. The mentum is large, and fills the buccal space, except in Eudiagogus, where it is small, leaving the maxillæ exposed. The antennæ are geniculate, with the scape usually very long; the club is pubescent and annulated. The eyes are usually rounded, but in several genera transverse and pointed below; in the latter case, but also in some of the round-eyed genera, the front margin of the prothorax is dilated forming post-ocular lobes; these lobes are sometimes very feeble and sometimes indicated only by a marginal row of long hairs (*vibrissæ* of Lacordaire). The front coxæ are contiguous in our genera. The trunk is short, even in the winged species, the epimera of the mesothorax project below the elytra to a greater or less extent; the episterna of the metathorax are either covered by the elytra, and indistinct, or narrow and very distinct. The hind coxæ are usually widely separated, the ventral segments are 5 (in one specimen of Nocheles but 4 are visible); the 1st and 2d larger, connate, 3d and 4th shorter, 5th a little longer. The lateral extension of the ventral segments is tolerably wide, broader behind; the dorsal segments are membranous, the last is corneous, divided in ♂ as usual, but the terminal portion apparently more retractile than in genuine Curculionidæ. The legs are moderate, tibiæ variable in form, tarsi spongy beneath, usually dilated, though sometimes (Ophryastes) very slightly so, and in Rhigopsis only sparsely ciliate.

The tribes of this family so far as represented in our fauna may be naturally grouped as follows:—

A. Side pieces of metathorax concealed, or indistinct; elytra connate:
   Antennal grooves short, on the upper face of the beak; or lateral and directed towards the eyes, eyes rounded, or nearly so, prothorax not lobed. . . . . OTIORHYNCHINI.

Antennal grooves lateral, directed below the eyes, which are rounded, prothorax not lobed: . . . . BRACHYDERINI.
Directed below the eyes, which are sometimes transverse, prothorax more or less lobed:
  Humeri rounded. . . . . LEPTOPSINI.
  Humeri angulated. . . . . RHIGOPSINI.
B. Side pieces of metathorax narrow, distinct:
  a. Elytra connate, humeri rounded:
    Eyes rounded, prothorax not or scarcely lobed. DYSLOBINI.
    Eyes transverse, prothorax lobed. . . . OPHRYASTINI.
  b. Elytra free, humeri distinct, wings perfect;
    I. Mentum large, beak short, flat;
      Antennal grooves very short, not oblique (eyes usually rounded and prothorax not lobed); outer stria of elytra entire . . . . PHYLLOBIINI.
      Antennal grooves longer, oblique, outer stria of elytra imperfect. . . . . TANYMECINI.
    II. Mentum large, beak rather long. . . EVOTINI.
    III. Mentum small, gula prominent; beak short, antennal grooves oblique, deep; eyes transverse, prothorax lobed in front. . . . . EUDIAGOGINI.

It will be seen after a short inspection of the characters above mentioned for the definition of the respective tribes, that the general arrangement in this family parallels in a remarkable manner that which I have developed in the Tenebrionidæ,* and which has been adopted by Dr Horn in his excellent monograph of that family, as represented in our fauna.† There is, namely, a higher series, characterized by large mentum and absence of wings, distinguished in the former case (Asididæ) by the ventral segments entirely corneous,‡ in the latter (A) by the indistinct side pieces of the metathorax. Then comes a second series, composed of two principal subseries, Blapsidæ in the former instance, with elytra widely extended on the flanks, and Tenebrionidæ with narrow epipleuræ, the first always apterous, the second mostly winged; in the present family we have (B–a) apterous, and (B–b) winged, and in the last, as in the genuine Tenebrionidæ, additional degradational characters in the oral organs, which, in the isolated genus Eudiagogus, have the same general form as in the short beaked species of the next family.

It is also worthy of remark that while the European species are very numerous, the representation in North America is but small, and that the highest form, Otiorhynchus, exists on this continent only as a few species imported with and parasitic on fruit trees, in the Atlantic States.

---

* Class. Col. N. America.

† Trans. Am. Phil. Soc., xiv, 253, sqq.

‡ The only instance in the Tenebrionidæ of this character, occurring outside of the Asidide series, is in a small group, Calcar, etc., otherwise allied to Tenebrionini.

On examining closely the part of the head adjacent to the eyes, a small oblique suture will be seen extending downwards from the anterior inferior part; if this fissure is entirely closed, the eye is round, as in the majority of the genera; if it is open the eye becomes more or less pointed at that part, and finally assumes the transverse, acuminate form observed in Ophryastes, etc. My attention was first directed to this peculiarity, by observing that in the few species of Otiorhynchus now domiciled in the United States, there are quite perceptible differences in the form of the eyes, which are more rounded in *O. arcticus*, and more pointed in *O. ligneus*. In Agraphus this fissure is more distinct, and the eye is accordingly more pointed.

The groups of Otiorhynchini are distinguished by the tarsal ungues and antennæ, as follows:

Ungues separate;
  Antennæ long and slender, ... Otiorhynchi.
  Antennæ thicker, ... Trachyphloei.
Ungues connate at base, ... Periteli.

The tribe Brachyderini as here limited is by no means that defined by Lacordaire under the same name. I have removed from it various groups having the humeri distinct, which will be found below and under Tanymecini; Sitones and its allies do not even belong to this family, but will be found among the first Curculionidæ, where the simple mandibles and small mentum entitle them to be placed.

Thus diminished, the tribe, as represented in our fauna, indicates but two groups, distinguished by the form of the beak:

Beak longer than the head, feebly auriculate, antennal grooves commencing on the upper surface; support of deciduous piece very prominent, eyes coarsely granulated, somewhat pointed below. AMOMPHI.

Beak scarcely longer than the head, not auriculate, support of deciduous piece very prominent; eyes finely granulated, subemarginate in front . . . . GEONOMI.

The first group is represented by a single undescribed species from Colorado; the accessory mandibular pieces are short, pyramidal, obtuse, and slightly curved.

The second group is represented by two species on the Atlantic slope, belonging to Epicaerus and Graphorinus; the body is pyriform and robust; the accessory mandibular pieces are not preserved in any of my specimens, but the process which supports them is longer and more prominent than in any other group.

With the tribe Leptopsini, and the anomalous Rhigopsis described below, the series having the side pieces of the metathorax indistinct or invisible is concluded. They differ essentially by the outline of the front margin of the prothorax being sinuous when viewed laterally, so as to form a broad lobe for the protection of the eyes, when the head is deflexed; and correlative with this the tip of the prosternum is broadly and feebly emarginate. The eyes are more or less transverse and pointed below, though nearly round in Phyxelis. The beak is moderate or rather long, sometimes wider at tip, and auriculate (*Hylobius? torpidus* Lec. and *Tyloderes? gemmatus* Lec.,) very much as in Otiorhynchus. The antennal grooves are visible from above, but descend obliquely, towards the inferior angle of the eye, which however they do not reach. Panscopus and Phyxelis represent this tribe in the Atlantic States, and also a species which I refer to Strangaliodes; the Pacific representatives are the two species above named, each indicating a new genus. I have a remarkable ♀ specimen of *H.? torpidus*, having but 4 ventral segments, one of the two short segments being wanting.

The second great division of the Otiorhynchidæ, in which the side pieces of the metasternum are well defined, though always narrow, may be separated into two principal types, according to the form of the beak.

In the first, the beak is moderate, or rather long, more or less thickened, with the antennal grooves (as in all the preceding), somewhat visible from above, and either directed towards the eyes, or obliquely downwards; the prothorax is truncate at base, the elytra are connate, and the humeri are rounded. The eyes vary in form, and the prothorax is either lobed or not, according as the eyes are transverse or rounded.

Apical process of mandibles pyramidal, acute:
Tibiæ with a terminal hook, ... Dyslobi.
Apical process not prominent:
Tibiæ normal, truncate at tip, ... Ophryastes.
Tibiæ expanded at tip,. . . . . Trigonoscutæ.

In the second type the beak is flat above, usually channelled, sometimes finely carinate, not expanded at tip; the antennal grooves are very narrow, parallel at their origin, and usually suddenly deflexed, though sometimes (Phyllobius) very short and straight. The eyes vary in form and the prothorax is lobed or not. The prothorax is usually bisinuate at base, with the hind angles acute, though sometimes truncate. The elytra are usually free, with prominent humeri, and the wings well developed: though sometimes they are connate, with rounded shoulders. The accessory mandibular piece is long and falcate in both, and the support at the tip of the mandible is circular and not prominent; characters of great moment when associated with the peculiar form of body.

Two tribes are indicated by a difference in the outer stria of the elytra:

Outer stria of elytra entire.	PHYLLOBIINI.
Outer stria of elytra abbreviated or interrupted . .	TANYMECINI.

The first tribe is represented by Pachnæus, and Phyllobius in the Atlantic States, and by Scythropus on both slopes of the continent. Of these Pachnæus has the eyes transverse, and the prothorax lobed at the sides in front, while in the others the eyes are rounded, and prominent, and the front outline of the prothorax is straight. The species are all winged, and the humeral angles are obtuse and well defined. The base of the prothorax is truncate in all the genera except Pachnæus, where it is distinctly bisinuate.

Macrostylus, a Brazilian genus recently found in Texas, is an anomalous member of this tribe. The antennæ are very long and slender, and the joints of the club seem to be quite separate and free. It is of very small size, and has the elytra connate and the humeral angles not prominent; the beak is not channelled, but otherwise resembles the beak of other members of the tribe. The claws are connate almost to the tip, as in Phyllobius, etc., while they are separate in Pachnæus. There are thus three groups indicated.

Prothorax lobed in front; claws separate: . . .	Pachnæi.
Prothorax not lobed; claws connate:	
Humeri prominent, elytra free:	Phyllobii.
Humeri not prominent, elytra connate: . . .	Macrostyles.

The Tanymecini resemble in form the Phyllobiini, but are readily distinguished by the outermost stria of the elytra being confluent with the next about $\frac{1}{3}$ from the base, or abbreviated at that point, or interrupted, the continuation commencing behind the middle and extending to the tip. The prothorax is bisinuate at base (Compsa, Brachystylus and Brachythysus), truncate or feebly rounded in Tanymecus, Aphrastus, and the genera with connate elytra. The eyes are rounded and the prothorax not lobed in all of our genera.

Four groups are indicated in our fauna.

Elytra connate, humeri not prominent, ...	Symmathetes.
Elytra not connate, humeri angulated;	
Claws connate, ...	Aphrasti.
Claws separate;	
Prothorax truncate at base, ...	Tanymeci.
Prothorax bisinuate at base, ...	Cyphi.

Next to this tribe come the Entimini, large and brilliant insects of South America; the rostrum is stout, not so broad as in the last two tribes, deeply emarginate at tip, perpendicular on the sides, thickened below at the tip, with the antennal grooves deep and oblique; the apical scar of the mandibles is very large, circular and not prominent. The eyes are pointed below, and the prothoracic lobes large. The prothorax is comparatively small, and bisinuate at base; the elytra at base very broad, with prominent humeri, gradually narrowed and acute behind; the outermost stria is entire. The edge of the elytra and the ventral sutures are densely fringed with short hair; the claws are not connate.

Two insects presenting anomalous characters remain to be considered, each indicating a separate tribe.

The first is found abundantly in Oregon; the beak is two and a half times as long as the head, moderately slender, dilated and auriculate at tip, which is deeply emarginate; the grooves are visible from above, short, broad and deep, prolonged very indistinctly in an oblique direction; the apical scar of the mandibles is large and circular, but not prominent. The eyes are nearly round, and not prominent. The antennæ are slender, and not different in form from those of Otiorhynchus. The prothorax is rather small, a little narrowed in front, not lobed, truncate behind. Elytra wider at base than the prothorax, humeral angles obtuse distinct, feebly rounded at the sides, obliquely narrowed behind; scutellum distinct. First ventral segments feebly sinuate, the others straight; side pieces of metasternum distinct. Legs slender, tibiæ feebly mucronate at tip; tarsi dilated, brush-like beneath, claws separate.

This species is from $10-11^{mm}$ ·4–·45 inch long, black, densely clothed with small cinereous scales, with lateral and dorsal vittæ of the prothorax, and scutellum pale yellow; the prothorax is sparsely punctured, and the elytra very feebly striate. I have named the genus Evotus. It is the *Otiorhynchus? naso* Lec. (Pac. R. R. Expl. and Surveys, p. 56).

The second of the anomalous forms above mentioned is a small, roughly tuberculate insect of the southern part of California, found under bark of yucca. It resembles in appearance the European Rhytirhinus, and shows unmistakable Byrsopide affinities. The mentum is, however, similar to that of the other Adelognaths of the present family, and the apical scar of the mandibles is distinct, flat and subtriangular, though without the central elevation usually seen. The tarsi are less dilated than usual, and sparsely ciliate beneath; the 3d joint is emarginate rather than bilobed, the claws separate. The rostrum is moderate in length, thick, irregular, not emarginate at tip, prominent above the eyes; the antennal grooves are deep and descend obliquely below the eyes which are pointed below, oblique and transverse. The scape of the antennæ extends nearly to the eyes; the funiculus is longer than the scape, 7-jointed as usual, with the 1st and 2d joints a little longer; club oval, pointed and annulated as usual. Prothorax strongly lobed behind the eyes, feebly emarginate beneath, broadly flattened (but not excavated) in front of the coxæ. The side pieces of the metathorax are *not distinct*, the 1st and 2d ventral segments are large, connate by a sinuated suture; 3d and 4th short, 5th longer than the 3d and 4th united, with a broad impression each side near the margin.

The species is of small size ($5{\cdot}5^{mm}$) brown, covered with a dirt colored crust, very roughly reticulate above, with large deep pits; the humeral angles are sharp and prominent; there is a large tubercle on each elytron about ¼ from the tip, and another smaller one near the tip. I have named this singular insect *Rhigopsis effracta.*

The last tribe having an apical scar to the mandibles is Eudiagogini, represented by two species in the southern Atlantic States. The form resembles somewhat the Tanymecini, but is rather stouter and more convex; the color is black adorned with narrow stripes and bands of metallic scales.

The beak is short and stout, channelled above, feebly emarginate at tip, with the antennal grooves narrow and deep, running obliquely below the eyes, which are transverse and pointed below. The mandibular scar is small and triangular, not prominent. I have not seen the deciduous piece, but suppose it to be small, short and pyramidal. The mentum is retracted leaving a deep cavity, from the hind margin of which projects the gula in a small emarginate prominence, much like the mentum-tooth in certain Carabidæ. The prothorax is broadly rounded at base, with the hind angles nearly rectangular; the postocular lobes are large, and the front margin of the prosternum is nearly squarely truncate, so as to make a rounded right angle with the outline of the postocular lobe. The front coxæ are contiguous, the side pieces of the metathorax narrow, distinct; the ventral segments 1st, 2d and 5th long, 3d and 4th short; 1st and 2d sutures feebly sinuate, but in reverse directions. Legs moderate, tibiæ with a small terminal spur at the inner side; tarsi with 3d joint broadly bilobed, claws approximate, but not connate.

A singularly isolated type, seeming to have no relations with any other in our fauna.

CURCULIONIDÆ.

After thus separating the families above defined, there remains a vast complex of genera having the sexual characters of this series, the antennæ geniculate (with rare exceptions), the club always oval pointed and annulated, uniformly pubescent; the mandibles without deciduous piece, usually 3-toothed at tip, which is perpendicular. The mentum is always small or moderate in size, not concealing the maxillæ, and inserted upon a more or less elongated gular peduncle. The beak varies in form, as will be pointed out under the respective tribes; the antennal grooves rarely extend to the front extremity of the beak (as in all the members of Otiorhynchidæ), but commence at a greater or less distance from the tip (except in Sitonini). The front coxæ are either contiguous or separated; the side pieces of the metathorax are always distinct: the pygidium is either covered by the elytra, or exposed.

The following principal divisions may be established:

A. Antennal grooves extending to the base of the mandibles, gular peduncle broad, not emarginate; (*Brachyrhynchi*).

Beak short, broad, gular margin not prominent, eyes round. SITONINI.
Beak short, very thick, buccal cavity deep. . . . . BATHYRINI.
Beak moderately long, gular margin prominent, peduncle and mentum retracted. . . . . ALOPHINI.
B. Antennal grooves not extending to the base of the mandibles;
A. Gular peduncle broad truncate, mandibles emarginate at tip (antennæ not geniculate, claws toothed); . . . . ITHYCERINI.
B. Gular peduncle long: (*Mecorhynchi*).

A careful analysis of the tribes composing the last division (Mecorhynchi) would extend this memoir to an unsuitable length for my present purpose, and must be reserved for the concluding part of my work on classification,* now in preparation. A few remarks upon the other four tribes, which might even be regarded as subfamilies, will however not be out of place. The types are well known with the exception of the second, Bathyrini, founded upon a very remarkable species from Arizona and Texas, which resembles somewhat a Cratoparis, of the family Anthribidæ; a resemblance increased by the hind angles of the prothorax in ♂ being expanded and flattened, so as to be as wide as the base of the elytra. The beak is not longer than the head, deeply constricted at base beneath, then suddenly expanded so as to be as broad as long, very thick, strongly channelled and deeply emarginate above. The antennal grooves are deep, extending to the base of the mandibles and flexed below the eyes, which are pointed below; the scape of the antennæ extends as far as the eye; the 1st joint of the funiculus is ⅓ as long as the scape; the 2d is about ½ as long as the 1st; the 3d–7th nearly equal in length, gradually a little thicker; club pubescent, oval, annulated as usual. The buccal cavity is very deep, and square. The gular peduncle is not visible, and the mentum small, narrow, and deep in the cavity; the mandibles are strong, their base very broad and transverse, the tip (so far as I can see) feebly emarginate. The prothorax is lobed behind the eyes, and the prosternum deeply, almost semicircularly, emarginate in front. The front coxæ are contiguous; the side pieces of the metasternum narrow; the sides of the elytra narrowly emarginate behind the humeri, scutellum transverse, wider behind; the sutures of the ventral segments are straight, and the segments less unequal than usual, the 3d and 4th together being longer than the others separately. The legs are short, the tibiæ truncate, feebly mucronate at tip, and with broad distinct *corbeilles;* the tarsi are broadly dilated, 3d joint deeply bilobed as usual; claws separate. I have named this genus Bathyris.

---

* Classification of the Coleoptera of N. America. Smithsonian Institution Miscell. Publications. 8vo.

B. dispar; oblong oval, black, thickly covered with large dirty brown scales, varied on the elytra with patches of paler cinereous, and with scattered darker scales; of these the most conspicuous is a lateral transverse spot in front of the middle; a larger indistinct apical blotch is marked with an oblique brownish line; the stria are represented by ten rows of quadrate punctures; the outer one not abbreviated nor confluent; scutellum transverse, cinereous scaly. Length 4–6^{mm}

Arizona, Dr. Webb; Texas, Dr. Horn. The specimen from Arizona has the thorax at base as wide as the elytra, the hind angles being expanded, flattened and acute, with the side margin acute; the sides in front of the angles are straight and oblique.

Four specimens from Texas, which I considered as females, have the prothorax rounded on the sides, narrower in front, scarcely subsinuate at base, which is not as wide as the elytra, with the hind angles not prominent, but slightly rounded. The general form is therefore as in Eudiagogus. I have seen a nearly allied species from the Argentine Republic.

The Sitonini contain small species greatly resembling in form Tanymecus of the family Otiorhynchidæ, but differing entirely by the mentum being small, and the maxillæ exposed; the gular peduncle is short and broad, but quite distinct, and is truncate at the front margin. The mandibles are emarginate at tip, and have no apical scar for the attachment of the deciduous piece which is characteristic of the preceding family. The beak is short, broad, flat and channelled above, emarginate at tip; the antennal grooves extend to the base of the mandibles; they are deep and well defined, and flexed obliquely downwards below the eyes; the eyes are rounded; the front margin of the prothorax is not lobed, and not emarginate beneath. The front coxæ are contiguous, the side pieces of the metathorax are narrow and separate; the ventral segments less unequal than usual, the suture between the 1st and 2d sinuated. The tibiæ are truncate at tip, the tarsi dilated and brushlike beneath, the claws separate and simple. The elytra at base are much wider than the prothorax, with the humeri oblique and prominent; wings developed in all of our species.

The tribe Alophini retains a remnant of a form seen otherwise only in the preceding family; the elytra are convex, with the humeri not prominent and the prothorax is comparatively small. The prominence of the gular margin easily distinguishes it from all other tribes. The tibiæ are slightly mucronate at the inner angle of the tip, and the terminal surface is well defined, not lateral. The apical margin of the mandibles is curved, sharp and prominent, thus making the outer face broad and flat, with a well defined margin. *Liophlœus inquinatus* Mann, from Alaska, belongs to this tribe, and seems scarcely different from Alophus, except by the shorter and stouter funiculus. *Lepidophorus lineaticollis* on the other hand has an entirely different oral structure, and is apparently allied to Phytonomus, etc.

Ithycerus is a completely isolated form, having no relation with other genera. As pointed out by Dr. Horn,* the remark of Prof. Lacordaire, that the ♂ has 6 ventral segments, is an erroneous interpretation of the very convex last dorsal segment, which can be seen from beneath.

BRENTHIDÆ.

The species of this family are remarkable for the very elongate form, and by the great sexual differences which sometimes occur in the mouth organs. In our own *Eupsalis minuta* for instance, the beak of the male is broad, short and flat, with large prominent mandibles, while in the female the beak is long and slender, with very small mandibles. But two genera occur in our fauna; Eupsalis on the Atlantic slope from Canada to Texas, and Brenthus in Lower California.

The mouth is not constructed on the same plan as that of the long beaked Curculionidæ; the gular peduncle is wanting, and the mentum varies in form according to the shape of the buccal opening, which it nearly fills, thus concealing the maxillæ. The family is also easily known by the antennæ being 11-jointed, not clavate nor geniculate, nearly moniliform in Eupsalis, somewhat compressed and broader externally in Brenthus.

The eyes are rounded, the lenses are covered with a perfectly smooth membrane, and are consequently not granulated, the front coxæ are separated by the prosternum; the metasternum is long, and the side pieces are distinct and very narrow. The 1st and 2d

---

* Proc. Am. Phil. Soc. 1873, 447.

ventral segments are very long, and closely connate; 3d and 4th short, 5th as long as the two preceding united. The tibiæ are truncate at tip, the front ones feebly unguiculate, and with the inner margin of the tip concave; tarsi dilated, brushlike beneath, 3d joint bilobed in our genera, 4th joint long, claws simple separate; the tarsi are less dilated in some exotic genera.

The dorsal segments are arranged exactly as in true Curculionidæ; they are all membranous except the last, which is corneous and convex in ♀, divided in ♂: the sides of the ventral segments are only narrowly prolonged upwards, and are imbricated; the last spiracle is large and uncovered. The elytra have on the inner side the usual lateral fold, but instead of becoming obsolete near the tip, it diverges strongly from the margin and is continued quite to the suture, fitting to the lateral edge of the last ventral segments, thus showing an approach to the peculiar modification afterwards seen in Scolytidæ.

Some of the most curious characters in the Rhynchophorous series occur in this family. Among them I may instance *Taphroderus distortus* Westwood, from Natal, remarkable by the enormous development of the left mandible; and *Calodromus Mellyi* Guerin, from India, in which the 1st joint of the hind tarsi is as long as the whole body.

SERIES III. HETEROGASTRA.

I have named this series from the fact, that although the abdominal segments are alike in both sexes, and the ventrals also prolonged upwards at the sides, fitting into a groove on the inner face of the elytra, as in the Allogastrous series, yet the best characters for the separation of the families are to be found in the particular modification of the arrangement of the last ventral segments.

Nothing distinctive can be predicated of the series as a whole, except the similar pygidium in both sexes, and the prolongation upwards of the ventral segments to fit in the elytral groove.

The families may be thus distinguished:

A. Pygidium vertical or declivous:
    a. Antennæ geniculate, clubbed; labrum wanting:
        Last spiracle covered etc. (sub-families etc.) . CALANDRIDÆ.
    b. Antennæ straight; labrum distinct:
        Last spiracle not covered by ventral segments; pygidium deeply notched to receive sutural apex of elytra. . . ANTHRIBIDÆ.

B. Pygidium horizontal; smaller:
  a. Antennæ geniculate, clubbed:
    Terminal edge of last ventral acute, surrounding the last dorsal; tibiæ generally compressed and serrate. . . SCOLYTIDÆ.
  b. Antennæ straight:
    Ventral segments very unequal, antennæ with annulated club. APIONIDÆ.
    Ventral segments nearly equal; antennæ with 11 separate joints. BELIDÆ.

CALANDRIDÆ.

Elytra with the usual fold on the inner face near the side very strongly developed; diverging behind, and becoming gradually effaced.

Ventral segments 3d and 4th shorter, 1st and 2d connate; lateral prolongations broad, imbricated; the sharp edge for reception in the elytral groove only developed on the 1st and 2d segments. Dorsal segments coriaceous, pygidium large, triangular, rounded at tip, declivous, alike in both sexes, though smaller in the third sub-family; last spiracle covered by prolongation of ventral segments.

* An excellent synopsis of the United States species of this family has been published by Dr. G. H. Horn.*

According to differences in the form of the mouth, the indigenous genera may be divided as follows:

A. Pygidium exposed:
  Gular peduncle long, ... CALANDRIDÆ.
B. Pygidium covered by elytra:
  Gular peduncle broad, mentum concealed, . . . RHINIDÆ.
  Gular peduncle moderate, mouth normal, ... COSSONIDÆ.

The mouth in this sub-family is formed upon a peculiar type not seen in the genuine Curculionidæ; the gular peduncle is extremely long and narrow, leaving the maxillæ visible in the buccal fissures; the mentum is small, sometimes concave, and the palpi not usually visible. The mandibles are convex on their outer face and strongly toothed at tip as in many Curculionidæ. The beak is long, curved and cylindrical, the antennæ inserted at a distance from the mouth, geniculate, with a large club which is corneous and smooth at base, spongy and pubescent over the rest of the surface. The eyes are transverse and finely granulated. The front coxæ are widely distant. The side pieces of the metasternum are large, and those of mesosternum also large, ascending obliquely. The hind coxæ are oval, and widely separated, the tibiæ are slender, sinuate, strongly unguiculate at tip, with the articular surface lateral; tarsi usually dilated, and brushlike beneath, sometimes narrow and not scopiferous; last joint rather long, claws simple, separate.

---

*Proc. Am. Phil. Society, 1873.

RHINIDÆ.

Again a different modification of mouth is seen in this sub-family. The gular peduncle becomes a broad short plate projecting forwards, forming the floor of the mouth, within which the mentum is concealed. The mandibles are smooth and very convex on the inner face, while the outer face is rough and flattened, and the teeth project outwards. The beak is long and slender. The antennæ are geniculate, the club is smooth and corneous at base, spongy and pubescent for the rest of the surface. The eyes are large and coarsely granulated, and meet on the under surface of the head. The front coxæ are very narrowly separated, the under surface of the body, and the dorsal segments are as in Calandridæ, except that the pygidium is covered by the elytra. Tibiæ slender, strongly hooked at tip, tarsi narrow, 3d joint bilobed, ciliate at the sides, not pubescent: 4th joint long, claws simple, separate.

A small black species of Rhina has been found by Mr. G. R. Crotch, in the trunks of Yucca in the Mohave Desert of California; otherwise the genus occurs generally in tropical America.

COSSONIDÆ.

With the same arrangement of abdominal segments above described, these insects have an oral structure similar to that of the Hylobiini in the true Curculionidæ. The gular peduncle is moderately long, the mentum distinct, and palpi large. The mandibles are normal in form, convex externally, toothed as usual at tip. The beak is moderate, or (Rhyncolus) short and stout. The eyes transverse, moderately finely granulated. The antennæ geniculate, rather stout, club oval annulated, pubescent. Front coxæ separate, tibiæ hooked at tip, tarsi narrow, 3d joint not dilated. Pygidium covered by the elytra, smaller than in the two preceding sub-families.

SCOLYTIDÆ.

The members of this family, which contains some of the most destructive enemies of forest trees, may be easily recognized by the peculiar arrangement of the last ventral segment, which is prolonged upwards along the whole lateral and apical margin, so that the pygidium is confined entirely to the dorsal surface, and, as it were, surrounded by this sharp edge.

The mouth is normal in form, the gular peduncle emarginate, the mentum moderate in size, prominent, buccal fissures broad, maxillæ exposed. Mandibles stout, curved, convex on the outer face, toothed on the inner side. Beak short, or almost wanting, antennæ short, geniculate, club usually solid, annulated on one or both sides, base usually smooth and corneous for a greater or less extent; rarely (Phlœotribus) the club is lamellated. Eyes usually large and transverse.

Front coxæ usually contiguous and subconical, hind coxæ large, not widely separated; tibiæ compressed, usually serrate on the outer edge, terminal spur large; tarsi sub-pentamerous, not spongy beneath, 3d joint sometimes narrow, sometimes dilated; 4th joint usually rudimentary, sometimes (Platypus) quite distinct, last joint long, claws simple, separate, strong.

The ventral segments are not very unequal in length, and the suture between the 1st and 2d is straight and well marked, the 5th is frequently the longest; the intercoxal process of the 1st is usually acute.

The dorsal segments are membranous, the pygidium is small and horizontal, covered by the elytra: the last spiracle is visible; the lateral upward prolongations of the ventral segments are well marked, and furnished with a sharp edge, continued even to the tip of the 5th segment. The lateral fold of the elytra is consequently well marked, the groove narrow and deep, gradually obliterated, but not wider toward the tip.

Two sub-families are indicated, Platypodidæ and Scolytidæ, the 1st with the basal joint of the tarsi very long, and the 4th distinct; the latter with the 1st joint shorter than the others united, and the 4th joint less developed.*

The synonymy of our species will probably present much difficulty, and the number is by no means that indicated by the names in the catalogues. The only connected series of descriptions is contained in the synopsis by Dr. Zimmermann, with an appendix by myself,* in which differential characters are given for the definition and distinction of each species. Many of the same have been described by Mr. Eichoff,† with diagnoses only, and no comparative or differential characters. For their identification, therefore, comparison of specimens will be necessary, or the completion of the promised monograph of the family from the hands of that author must be awaited.

---

* On p. 389, of vol. vii of the Genera des Coléoptères, Lacordaire has established a tribe Eutomides, which differs from all the others in having the flanks of the prothorax separate from the pronotum by a distinct edge; and the mass of the antennæ composed of 7 lamellate joints. These characters are so foreign to the Rhynchophora, that I cannot help suspecting that these insects have been misplaced. I sought for specimens in all of the large European collections which I visited, but without success.

ANTHRIBIDÆ.

In this family of the Rhynchophora there is as near an approach to the normal Coleoptera as is observed in Rhinomaceridæ, the first family herein defined.

The beak is short or moderate, depressed above, with the antennæ inserted in foveæ or short grooves which are usually lateral, rarely (Choragus, etc.) on the upper face; the antennæ are not geniculate, with 11 distinct joints, rarely (Hormiscus) but 10: the scape is not elongated. The labrum is quite distinct; the mouth is normal in structure, the gular peduncle large and deeply emarginate, with the mentum and ligula received in the emargination, the maxillæ are exposed and have two distinct lobes, a character unknown in the preceding families, except in some Platypodidæ; mandibles flattened, curved and acute at tip, toothed on the inner side. Eyes large, rather finely granulated, rounded or emarginate. The front coxæ are contiguous or narrowly separated, rounded; the pronotum is sharply margined behind, and the margin is frequently distant from the base, curved forwards at the sides. The side pieces of the metasternum are distinct. The ventral segments are nearly equal, and rather closely connected, except the 5th which is free: the lateral prolongations are rather wide, *not imbricated*, and the sharp edge is well marked. The dorsal segments are membranous, except the pygidium which is rather large, deflexed and only partly covered by the elytra; the last spiracle is large and visible when the elytron is raised; the base of the pygidium is very deeply notched (so that the uncovered part appears slightly emarginate), and the sutural edge of the elytra (which is grooved for its whole extent) is bent down and slightly prolonged at tip so as to fit into this excavation. The lateral fold of the inner surface of the elytra is well marked for the middle third, but is distant from the side, and gradually obliterated behind, following along the 2d line of punctures from the side. The tibiæ are slender, truncate at tip, with feebly developed spurs, never mucronate; the tarsi are dilated and brush-like beneath, the 2d joint usually deeply emarginate, receiving the 3d joint in the emargination: the 3d is usually narrower and shorter than the 2d and also emarginate: the last joint moderate in length, claws separate toothed.

---

* Trans. Am. Ent. Soc., ii. 141, Sept., 1868.

† Berliner Ent. Zeitschrift, 1868 et sqq.

As observed by Lacordaire,* when the sexual differences are well marked the male is larger than the female, and the beak of the latter is shorter: the reverse being the case in all other families of Rhynchophora. There are also sometimes great differences in the antennæ and front legs which are much longer in the male.

The larvæ of some species of Brachytarsus (*Anthribus* Geoff.) are parasitic on certain species of Coccus: the only example thus far ascertained of carnivorous habits among the Rhynchophora.

APIONIDÆ.

In this family the last dorsal segment is horizontal and small as in the Scolytidæ, but the other characters are quite different.

The beak is long and slender, the mouth small, the gular peduncle rather narrow and emarginate, the mandibles feeble, and acute. The antennæ are not geniculate, the scape is somewhat elongated; they are inserted on the side of the beak at or above the middle, and the grooves are very short; the eyes are rounded, rather coarsely granulated.

The prothorax is not lobed in front, the coxæ are contiguous, conical and prominent. The side pieces of the metathorax are distinct, narrow. The tibiæ are slender, truncate at tip; hind pair without spurs; the claws are separate, more or less toothed at the base.

The dorsal segments are membranous: the last segment (pygidium) is horizontal, rather small and corneous, entirely covered by the elytra; at the side it meets only the 5th ventral, and the last spiracle is not apparent: the ventral segments are very unequal, the 1st and 2d very large connate, 3d and 4th very short, sutures straight: lateral prolongation very narrow: groove on the inner side of elytra narrow, gradually broader behind, fold extending nearly to the suture (somewhat as in Brenthidæ).

---

* *l. c.* vii, 480.

This family is represented by Apion, a genus containing a large number of small species of pyriform body, and altogether peculiar and of easily recognized appearance. So far as I have examined them they have well developed wings, though Lacordaire mentions that the body is apterous. This family is related to the Erirhine tribe of true Curculionidæ.

BELIDÆ.

The Australian genus Belus, and the South American Homalocerus, on examination present so many differences that I have separated them to form a new family, which must be placed in the present series. In fact, with a form of body greatly resembling Lixus of the true Curculionidæ, they have the dorsal abdominal segments of Apion; the ventral segments are, however, equal or nearly so; the lateral prolongation is very narrow, and although the edge is acute, the lateral fold on the inner face of the elytra extends only in the middle third, and is nearly confluent with the margin at its front end. The antennæ are slender, 11-jointed, straight, and the scape is moderately long. The tibiæ are slender, truncate at tip, and the hind pair have two small but distinct spurs as in normal Coleoptera.

In the ♂ of Belus the apex of the elytra is prolonged as in many species of Lixus; and this family seems related to the Cleonine tribe of Curculionidæ as Apion is to the Erirhine. A slight trace of epipleura may be observed at the front part of the elytral side margin, thus showing also a relationship with the Rhynchitidæ of the first series, in which, as I have above mentioned there is a feeble fold on the inner face of the elytra about the middle, but quite distant from the margin.—*Concluded.*

HERBARIUM CASES.

BY DR. C. C. PARRY.

NOTWITHSTANDING the lucidly expressed opinion of the present official authority in Washington, dignified with the high sounding title of the Honorable Commissioner of Agriculture, or the "unimportance of the routine duties of the herbarium botanist," there has probably never been a time in the history of scientific botany, when greater attention has been given to this very important subject.

More especially is this true of a rapidly increasing class of local or amateur "herbarium botanists," who are intent on the collection and preservation for convenient reference and study, of limited floras, or particular natural orders of plants.

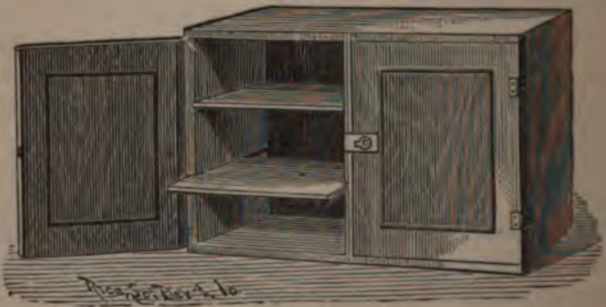
Having had occasion from a somewhat prolonged experience as a botanical collector, to realize the want in my own case as well as to observe the frequent loss of valuable material by others, from the lack of suitable herbarium appliances, I have been led to adopt a simple contrivance with a view to meet the *desideratum*.

While for very extensive and permanently located herbaria, such as that of Prof. Gray at Harvard, stationary cases are perhaps more desirable on the score of economy; still there is a manifest advantage in having a somewhat portable character to such depositories, in order that necessary additions can be incorporated into the general collection with least disturbance of the original arrangement. More especially in the much larger class of collections subject to removal, is it advisable to provide for such contingencies, by separate portable cases.

Still another advantage of such an arrangement is in limiting the depredation of destructive insects within narrow limits, where they can be checked without the great expense of going over an entire collection. In this view, (somewhat on the plan adopted in the British museum), I have adopted cases of the following description.

These cases consist essentially of an evenly partitioned box, with double doors, black walnut (or hard wood) fronts, finished flush on the outside, with no irregular projections of knobs or catches, so that for distant transportation they can be snugly enclosed in rough outside boxes (two or more together). The inside in each apartment has a capacity of 18½ inches in height, by 13½ inches in breadth, and 18½ inches in depth. Each space is divided by two movable slides, into three equal divisions, or six to each case. The doors are bevelled on the inside, with a corresponding bevel on the case, to which they are attached by outside hinges, so that in opening at a right angle there are no sharp edges to hinder the drawing out of the herbarium papers; as well as allowing the cases to stand close side by side, without interfering with the free opening of the doors, which can swing clear back against the sides without bringing any strain upon the hinges. In packing for removal, remove the papers and slides, turn the cases on their backs, and lay in the papers in regular order compactly filling each space with additional padding if necessary. The removed wooden slides can, in case the ordinary sized herbarium sheets are used, be placed breadth-ways at the side of the papers, or separately packed in one of the vacant cases.

Fig. 83.



The measurements as above given are such as are adapted to the size usually recommended of herbarium sheets, and genus covers, or medium wrapping paper size, allowing a small margin for occasional large specimens, or ease of storage and drawing out. These dimensions can of course be modified to suit particular cases, without interfering with the general plan.

By a slight modification on the inside, drawers may be substituted for slides, to receive bulky or irregular specimens, such as fruits, cones, wood sections, etc., still keeping up a desired uniform outside appearance.

In the permanent herbarium, these cases can be snugly piled one on the other, in tiers three or four in height, and closely fitting at the sides. The lower cases might be raised a foot or more above the floor, or the least used orders, or duplicates, kept in the lowest space.

The height of two cases (39 inches) would be convenient in looking over and comparing specimens, and where scarcity of case room is not urgent, the best lighted spaces might be arranged at this height.

At a rough estimate such cases may be calculated to hold conveniently six hundred species of average botanical specimens.

The cost of such cases, depending of course, largely on the material used, and amount of finish, etc., has been fixed by a manufacturing firm here in Davenport, Iowa (M. B. Cochran & Co., school furniture dealers), at $6.50 per case. For a larger number (ten or more), or in case of an increased demand, the price could be materially reduced. I am indebted to the above firm for the use of the wood-cut, here given to illustrate this subject. The particular adaptation of such cases for school uses, to contain in convenient form the necessary material for illustrating botanical lessons, is too obvious to require more than simple mention at this time.

CHARLES ROBERT DARWIN.*

Charles Robert Darwin was born at Shrewsbury on Feb. 12, 1809. He is the son of Dr. Robert Waring Darwin, F.R.S., and grandson of Dr. Erasmus Darwin, F.R.S., author of the "Botanic Garden," "Zoonomia," etc.; by the mother's side he is grandson of Josiah Wedgwood, F.R.S., the celebrated manufacturer of pottery. Mr. Darwin was educated at Shrewsbury School under Dr. Butler, afterwards Bishop of Lichfield, and in the winter of 1825 went to Edinburgh University for two years. He there attended to marine zoology, and read before the Plinian Society at the close of 1826 two short papers, one on the movement of the ova of Flustra. From Edinburgh Mr. Darwin went to Christ's College, Cambridge, where he took his Bachelor of Arts degree in 1831. In the autumn of 1831, Capt. FitzRoy having offered to give up part of his own cabin to any naturalist who would accompany H.M.S. *Beagle* in her surveying voyage round the world, Mr. Darwin volunteered his services without salary, but on condition that he should have the entire disposal of his collections, all of which he deposited in various public institutions. The *Beagle* sailed from England Dec. 27, 1831, and returned Oct. 22, 1836.

---

* From "Nature," June 4, with a Portrait.

Mr. Darwin married his cousin, Emma Wedgwood, in the beginning of 1839, and has lived since 1842 at Down, Beckenham, Kent, of which county he is a magistrate.

The Royal Society awarded to Mr. Darwin, in 1853, the Royal Medal, and in 1864 the Copley Medal. In 1859 the Geological Society awarded him the Wollaston Medal. He is an honorary member of various foreign scientific Societies, and is a Knight of the Prussian Order of Merit.

Since his return from South America in the *Beagle*, Mr. Darwin's life has been comparatively uneventful, even for a scientific man; indeed, so far as the public is concerned, the main events in Mr. Darwin's career have been the publication of his works and papers, which have been far more numerous than many are aware of. We give below a list of them:—

General Works. Journal of Researches into the Natural History and Geology of the countries visited by H.M.S. *Beagle*, 1845.

On the Origin of Species by means of Natural Selection, 1859.

This was preceded by a sketch, entitled "On the variation of organic beings in a state of nature;" published in the *Journal of the Linnæan Society*, vol. iii (Zool.), 1859, p. 46.

The Variation of Plants and Animals under Domestication. 2 vols. 1868.

The Descent of Man, and Selection in relation to Sex. 2 vols. 1871.

The Expression of the Emotions in Man and Animals. 1872.

Zoological Works. The Zoology of the voyage of H.M.S. *Beagle*, edited and superintended by C. Darwin, 1840; consisting of five parts.

A monograph of the Cirripedia, Part I, Lepadidæ; Ray Soc., 1851, pp. 400.

A monograph of the Cirripedia, Part 2, the Balanidæ; Ray Soc., 1854, pp. 684.

A monograph of the Fossil Lepadidæ; Pal. Soc., 1851, pp. 86.

A monograph of the Fossil Balanidæ and Verrucidæ; Pal. Soc., 1854, pp. 44.

Observations on the Structure of the genus Sagitta; Ann. Nat. Hist., vol. xiii, 1844.

Brief descriptions of several terrestrial Planariæ, and of some marine species; Ann. Nat. Hist., vol. xiv, 1844, p. 241.

Botanical Works. On the various contrivances by which British and Foreign Orchids are fertilized, 1862.

On the Movements and Habits of Climbing Plants; Journ. Linn. Soc., vol. ix, 1865, (Bot.), p. 1.—This Paper has also been published as a separate work.

On the action of Sea-water on the Germination of Seeds; Journ. Linn. Soc., vol. i, 1857 (Bot.), p. 130.

On the Agency of Bees in the Fertilization of Papilionaceous Flowers; Ann. Nat. Hist., vol. ii, 1858, p. 459.

On the Two Forms or Dimorphic Condition of the species of Primula; Journ. Linn. Soc., vol. vi, 1862 (Bot.), p. 77.

On the Existence of Two Forms and their reciprocal Sexual Relations in the genus Linum; Journ. Linn. Soc., vol. vii, 1863 (Bot.), p. 69.

On the Sexual Relations of the Three Forms of Lythrum; Journ. Linn. Soc., vol. viii, 1864, p. 169.

On the Character and Hybrid-like nature of the illegitimate Offspring of Dimorphic and Trimorphic Plants; Journ. Linn. Soc., vol. x, 1867 (Bot.), p. 393.

On the Specific Difference between *Primula veris* and *P. vulgaris*, and on the Hybrid Nature of the common Oxslip; Journ. Linn. Soc., vol. x, 1867 (Bot.), p. 437.

Notes on the Fertilization of Orchids; Ann. Nat. Hist., Sept., 1869.

Geological Works. The Structure and Distribution of Coral-reefs, 1842; pp. 214.

Geological Observations on Volcanic Islands, 1844; pp. 175.

Geological Observations on South America, 1846; pp. 279.

On the Connection of the Volcanic Phenomena in South America, etc.; Trans. Geol. Soc., vol. v; read March, 1838.

On the Distribution of the Erratic Boulders in South America; Trans. Geol. Soc., vol. vi; read April, 1841.

On the Transportal of Erratic Boulders from a lower to a higher level; Journ. Geol. Soc., 1848, p. 315.

Notes on the Ancient Glaciers of Caernarvonshire; Phil. Mag., vol. xxi, 1842, p. 180.

On the Geology of the Falkland Islands; Journ. Geol. Soc., 1846, pp. 267.

On a Remarkable Bar of Sandstone off Pernambuco; Phil. Mag., Oct., 1841, p. 257,

On the formation of Mould; Trans. Geol. Soc., vol. v, p. 505; read Nov., 1837.

On the Parallel Roads of Glen Roy; Trans. Phil. Soc., 1839, p. 39.

On the Power of Icebergs to make Grooves on a Submarine Surface; Phil. Mag., Aug., 1855.

An account of the Fine Dust which often falls on vessels in the Atlantic Ocean; Proc. Geol. Soc., 1845, p. 26.

Origin of the Saliferous Deposits of Patagonia; Journ. Geol. Soc., vol. ii, 1838, p. 127.

Part Geology; Admiralty Manual of Scientific Inquiry, 1849. Third ed., 1859.

NOTICE BY ASA GRAY.

Two British naturalists, Robert Brown and Charles Darwin, have, more than any others, impressed their influence upon science in this nineteenth century. Unlike as these men and their works were and are we may most readily subserve the present purpose in what we are called upon to say of the latter by briefly comparing and contrasting the two.

Robert Brown died sixteen years ago, full of years and scientific honors, and he seems to have finished several years earlier all the scientific work that he had undertaken. To the other, Charles Darwin, a fair number of productive years may yet remain, and are earnestly hoped for. Both enjoyed the great advantage of being all their lives long free from any exacting professional duties or cares, and so were able in the main to apply themselves to research without distraction and according to their bent. Both, at the beginning of their career, were attached to expeditions of exploration in the southern hemisphere, where they amassed rich stores of observation and materials, and probably struck out, while in the field, some of the best ideas which they subsequently developed. They worked in different fields and upon different methods; only in a single instance, so far as we know, have they handled the same topic; and in this the more penetrating insight of the younger naturalist into an interesting general problem may be appealed to in justification of a comparison which some will deem presumptuous. Be this as it may, there will probably be little dissent from the opinion that the characteristic trait common to the two is an unrivalled scientific sagacity. In this these two naturalists seem to us, each in his way, preëminent. There is a characteristic likeness, too—underlying much difference—in their admirable manner of dealing with facts closely, and at first hand, without the interposition of the formal laws, vague ideal conceptions, or "glittering generalities" which some philosophical naturalists make large use of.

A likeness may also be discerned in the way in which the works or contributions of predecessors and contemporaries are referred to. The brief historical summaries prefixed to many of Mr. Brown's papers are models of judicial conscientiousness. And Mr. Darwin's evident delight at discovering that some one else has "said his good things before him," or has been on the verge of uttering them, seemingly equals that of making the discovery himself. It reminds one of Goethe's insisting that his views in morphology must have been held before him and must be somewhere on record, so obviously just and natural did they appear to him.

Considering the quiet and retired lives led by both these men, and the prominent place they are likely to occupy in the history of science, the contrast between them as to contemporary and popular fame is very remarkable. While Mr. Brown was looked up to with the greatest reverence by all the learned botanists, he was scarcely heard of by any one else; and out of botany he was unknown to science except as the discoverer of the Brownian motion of minute particles, which discovery was promulgated in a privately printed pamphlet that few have ever seen. Although Mr.

Darwin had been for twenty years well and widely known for his "Naturalist's Journal," his works on "Coral Islands," on "Volcanic Islands," and especially for his researches on the Barnacles, it was not till about fifteen years ago that his name became popularly famous. Since then no scientific name has been so widely spoken. Many others have had hypotheses or systems named after them, but no one else that we know of a department of bibliography. The nature of his latest researches accounts for most of the difference, but not for all. The Origin of Species is a fascinating topic, having interests and connections with every branch of science, natural and moral. The investigation of recondite affinities is very dry and special; its questions, processes, and results alike—although in part generally presentable in the shape of morphology—are mainly, like the higher mathematics, unintelligible except to those who make them a subject of serious study. They are especially so when presented in Mr. Brown's manner. Perhaps no naturalist ever recorded the results of his investigations in fewer words and with greater precision than Robert Brown; certainly no one ever took more pains to state nothing beyond the precise point in question. Indeed we have sometimes fancied that he preferred to enwrap rather than to explain his meaning; to put it into such a form that, unless you follow Solomon's injunction and dig for the wisdom as for hid treasure, you may hardly apprehend it until you have found it all out for yourself, when you will have the satisfaction of perceiving that Mr. Brown not only knew all about it, but had put it upon record long before. Very different from this is the way in which Mr. Darwin takes his readers into his confidence, freely displays to them the sources of his information, and the working of his mind, and even shares with them all his doubts and misgivings, while in a clear and full exposition he sets forth the reasons which have guided him to his conclusions. These you may hesitate or decline to adopt, but you feel sure that they have been presented with perfect fairness; and if you think of arguments against them you may be confident that they have all been duly considered before.

The sagacity which characterizes these two naturalists is seen in their success in finding decisive instances, and their sure insight into the meaning of things. As an instance of the latter on Mr. Darwin's part, and a justification of our venture to compare him with the *facile princeps botanicorum*, we will, in conclusion, allude to the single instance in which they took the same subject in hand. In his papers on the organs and modes of fecundation in Orchideæ and Asclepiadeæ, Mr. Brown refers more than once to C. K. Sprengel's almost forgotten work, shows how the structure of the flowers in these orders largely requires the agency of insects for their fecundation, and is aware that "in Asclepideæ . . . the insect so readily passes from one corolla to another that it not unfrequently visits every flower of the umbel." He must also have contemplated the transport of pollen from plant to plant by wind and insects; and we know from another source that he looked upon Sprengel's ideas as far from fantastic. Yet instead of taking the single forward step which now seems so obvious, he even hazarded the conjecture that the insect-forms of some Orchideous flowers are intended to deter rather than to attract insects. And so the explanation of all these and other extraordinary structures, as well as of the arrangement of blossoms in general, and even the very meaning and need of sexual propagation, were left to be supplied by Mr. Darwin. The aphorism "Nature abhors a vacuum" is a characteristic specimen of the science of the Middle Ages. The aphorism "Nature abhors close fertilization," and the demonstration of the principle, belong to our age, and to Mr. Darwin. To have originated this, and also the principle of Natural Selection—the truthfulness and importance of which are evident the moment it is apprehended—and to have applied these principles to the system of nature in such a manner as to make, within a dozen years, a deeper impression upon natural history than has been made since Linnæus, are ample title for one man's fame.

There is no need of our giving any account or of estimating the importance of such works as the "Origin of Species by means of Natural Selection," the "Variation of Animals and Plants under Domestication," the "Descent of Man, and Selection in relation to Sex," and the "Expression of the Emotions in Man and Animals,"—a series to which we may hope other volumes may in due time be added. We would rather, if space permitted, attempt an analysis of the less known, but not less masterly, subsidiary essays upon the various arrangements for ensuring cross-fertilization in flowers, for the climbing of plants and the like. These, as we have heard, may before long be reprinted in a volume, and supplemented by some long-pending but still unfinished investigations upon the action of Dionæa and Drosera — a capital subject for Mr. Darwin's handling.

Apropos to these papers, which furnish excellent illustrations of it, let us recognize Darwin's great service to natural science in bringing back to it Teleology: so that, instead of Morphology *versus* Teleology, we shall have Morphology wedded to Teleology. To many, no doubt, Evolutionary Teleology comes in such a questionable shape as to seem shorn of all its goodness; but they will think better of it in time, when their ideas become adjusted, and they see what an impetus the new doctrines have given to investigation. They are much mistaken who suppose that Darwinism is only of speculative importance and perhaps transient interest. In its working applications it has proved to be a new power, eminently practical and fruitful.

And here, again, we are bound to note a striking contrast to Mr. Brown, greatly as we revere his memory. He did far less work than was justly to be expected from him. Mr. Darwin not only points out the road, but labors upon it indefatigably and unceasingly. A most commendable *noblesse oblige* assures us that he will go on while strength (would we could add health) remains. The vast amount of such work he has already accomplished might overtax the powers of the strongest. That it could have been done at all under constant infirm health is most wonderful.

A KEY TO THE HIGHER ALGÆ OF THE ATLANTIC COAST, BETWEEN NEWFOUNDLAND AND FLORIDA.

BY PROF. D. S. JORDAN.

PART II. RHODOSPERMEÆ.

(RED ALGÆ).

Plants rosy red or purple, rarely brown-red or greenish red, becoming, when exposed to sunlight, dull green or yellowish. Fructification of two kinds; diœcious:—1. *Spores* contained either in external or immersed conceptacles, or densely aggregated together and dispersed in masses throughout the substance of the frond; 2. *Tetraspores*, red or purple, either external or immersed in the frond, rarely contained in proper receptacles; each tetraspore enveloped in a pellucid skin, and at maturity splitting into four sporules. Antheridia filled with yellow or hyaline corpuscles. Ours all marine (except *Bostrychia*), and chiefly below low water mark. **A**

A. *Frond calcareous, rigid: its cells containing Carbonate of Lime,* . . . . CORALLINACEÆ. **P**

A. *Frond expanding horizontally, lichen-like, but not calcareous,* . . . . SQUAMARIÆ. **V**

A. *Frond not calcareous nor lichenoid,* . . . . **B**
B. *Frond mostly cylindrical, partly or entirely articulate,* . **C**
B. *Frond not articulate anywhere,* . . . . **G**
C. *Nodes much constricted,* . . . . **D**
C. *Nodes not specially constricted,* . . . . **E**
D. *Joints obvious throughout, long in the main stems and gradually shorter above, spherical at the tips; color bright, sometime gold-tinted,* . . GRIFFITHSIA in CERAMIACEÆ. **d**

D. *Terminal joints not spherical: colors duller, often greenish,* CHAMPIA in LAURENCIACEÆ. **W**

E. *Sporiferous nucleus in external spherical conceptacles: axis polysiphonous (of 4 or more tubes): joints not distinct on older parts of frond,* . RHODOMELACEÆ. **M**

E. *Axis monosiphonous: joints usually obvious: colors mostly bright,* . . . . **F**
F. *Branches beset with short, fine, mostly simple filaments* SPYRIDIACEÆ. **f**

F. *Not as above; mostly profusely branching; frond sometimes two edged,* . . . . CERAMIACEÆ. **d**

G. *Frond flat, with an evident midvein,* . . . . SPHÆROCOCCOIDEÆ. **Q**

G. *Frond without a midvein,* . . . . **H**
H. *Sporiferous nucleus consisting of tufted spore-threads attached to a placenta; single spores in each cell of the spore thread, or only in the terminal cell. (Fronds rarely flat or fan-shaped, mostly less leathery in texture than the next.)* . . . . **J**

H. *Sporiferous nucleus subglobose, either simple or formed of many nucleoli; numerous spores without order in a membranaceous mother-cell. (Fronds leathery, often large, and rarely adhering closely to paper.)* . . . **I**

I. *Frond composed of polygonal cells; often flat or fan-shaped,* RHODYMENIACEÆ. **X**

I. *Fronds various, rarely truly fan-shaped; the ultimate structure being jointed filaments compacted together by gelatine,* . . . . . . CRYPTONEMIACEÆ. **Z**

J. *Nucleus in an external, ovate or spherical conceptacle,* . **K**

J. *Nucleus not as above; cylindrical, dichotomously forked,* **L**

K. *Cylindrical; branches mostly tapering towards base and apex; superficial cellules very minute,* . . . . . GELIDIACEÆ. **T**

K. *Cylindrical or flat; surface covered with small cells; branches not tapering to base (except in* CHONDRIA*)* RHODOMELACEÆ. **M**

K. *Without above combinations; frond flat in our species,* SPHÆROCOCCOIDEÆ. **Q**

L. *Nucleus in wart-like excrescences; frond fan-shaped; apices attenuate, of equal length,* . SPONGIOCARPEÆ. **U**

L. *Nucleus immersed in the frond; apices blunt,* . . . . HELMINTHOCLADEÆ. **W**

M. Frond cylindrical, at least the branchlets or younger parts articulate, ... **N**

M. Frond not articulate anywhere, ... **O**

N. Frond elongated; main stem mostly inarticulate, but thickly beset with fine jointed branching filaments which bear the fruit, ... *Dasya.* **v**

N. Joints of frond, longitudinally striate; mostly dark red, and profusely branching, ... *Polysiphonia.* **m**

N. Frond tessellated with oblong or squarish, purple cells; small—about 1 inch high, ... *Bostrychia.* **u**

O. Frond flat, pinnatifid; obscurely midribbed, . . *Odonthalia.* **g**

O. Cylindrical; branches tapering toward the base, . *Chondria.* **h**

O. Cylindrical; branches not tapering to base, . . *Rhodomela.* **k**

P. Frond pinnate: jointed; 2 to 4 inches high, . . . *Corallina.* **x**

P. Frond lobed or orbicular, attached by its base or centre, . . *Melobesia.* **y**

P. Frond a red incrustation on rocks in deep water, *Nullipora* (?). **z**

Q. Tetraspores in definite sori; frond flat, with a midvein, . . . **R**
Q. Frond flat, without a midvein; spores not in sori, ... **S**
R. Delicate, rosy red; lamina unbranched; no lateral veins, . . *Grinnellia.* **A^2**
R. Fronds with veins and veinlets or else branched, . *Delesseria.* **B^2**
S. Frond compressed in our species, laciniate, . . *Gracilaria.* **E^2**
S. Frond flat, laciniate, delicate and rosy, often veiny, *Nitophyllum.* **C^2**
S. Frond flat, leathery, margined with wing-like segments, . . . *Calliblepharis.* **D^2**
T. Frond slightly compressed; branchlets slender at base, *Gelidium.* **F^2**
T. Coarser; cylindrical; succulent and flaccid, . . . *Solieria.* **G^2**
T. Frond filiform, much branched; branches clothed with small pointed branchlets, ... *Hypnea.* **H^2**
U. Dark brown, cartilaginous; not adhering to paper, . *Polyides.* **I^2**
V. Suborbicular; red-black, ... *Peyssonnelia.* **J^2**
W. Regularly dichotomous and level-topped, ... *Scinaia.* **L^2**
W. Sparingly dichotomous; worm-like, ... *Nemalion.* **K^2**
X. Frond flat, fan-shaped, multifid, ... **Y**
X. Frond linear, two-edged, pectinate-pinnatifid, . *Plocamium.* **O^2**
X. Frond terete, alternately decompound, . . . *Cordylecladia.* **P^2**
Y. Frond stipitate, palmately cleft; usually large and dark, . . . *Rhodymenia.* **M^2**
Y. Roseate; dichotomously or pinnately multifid, . . *Euthora.* **N^2**
Z. More or less flattened or compressed, ... **a**
Z. Cylindrical, ... **b**
a. Frond stipitate, regularly fan-shaped, very variable in color and form; shallow water, ... *Chondrus.* **W^2**
a. Frond stipitate, irregularly cleft, proliferous; deeper water, *Phyllophora.* **Q^2**
a. Channelled on one side, convex on the other; covered with little tubercles or frondlets, ... *Gigartina.* **V^2**
a. Frond rigid, 2 to 3 inches high; dichotomous; axils rounded; apices blunt, ... *Gymnogongrus.* **R^2**
a. Frond 1 to 2 feet long; margin fringed, with frondlets, . . . *Grateloupia.* **a^2**
a. Frond broad, palmate, fringed with cilia; brilliant. *Callophyllis.* **U^2**
b. Frond stiff, very rigid and horny; axils rounded, . *Ahnfeltia.* **S^2**
b. Frond very bushy; branchlets with a chain of swollen nodes containing conceptacles, or else tendril bearing, ... *Cystoclonium.* **T^2**
b. Frond delicate, much branched, adhering closely to paper, *Gloiosiphonia.* . . . . **b^2**
b. Not as above, and less common, ... **c**
c. Frond hollow, simple or with similar hollow branches, . . . *Halosaccion.* **Y^2**
c. Branchlets mostly opposite and tapering to base; usually secund or arching, stem constricted, adheres to paper, *Chylocladia.* **X^2**

c.	Fronds level topped, dichotomous; axils and apices acute; ends in fruit swollen into pod-shaped receptacles, *Furcellaria.*	Z^2
d.	Frond decidedly constricted at the nodes, *Griffithsia.*	j^2
d.	Frond two edged, decompound pinnate, pinnæ opposite, *Ptilota.*	g^2
d.	Frond filiform,	e
e.	Tetraspores sunk in the frond; axils rounded; branches dichotomous and commonly ending in little forks, which are often incurved, *Ceramium.*	d^2
e.	Tetraspores external; much branched; rarely dichotomous or with the apices hooked, *Callithamnion.*	k^2
e.	Tetraspores external; whorls of short, curved branchlets at the nodes, *Halurus.*	i^2
f.	Surface coated with small cells, *Spyridia.*	c^2
g.	Pinnately decompound; axils obtuse, apices acute,	54
h.	Branchlets club-shaped, obtuse,	i
h.	Branchlets acute at each end,	j
i.	Stem stout, mostly excurrent,	55
i.	Slender, generally forking near base,	56
j.	Frond slender, with setaceous branchlets,	57
j.	Stout, with thick branchlets,	58
k.	Substance soft, closely adhering to paper,	l
k.	Rather rigid; scarcely adhering to paper,	59
l.	Brownish red, pinnately much branched,	60
l.	Rosy, staining paper; more slender and regularly pinnate,	61
m.	Primary tubes four only,	n
m.	Primary tubes 6 to 25,	s
n.	Visibly articulate throughout; dissepiments pellucid,	o
n.	Stem and larger branches apparently not jointed,	r
o.	Branches widely spreading, beset with spine-like branchlets,	p
o.	Branches not spinous nor divaricate,	g
p.	Rigid and bushy; not collapsing when drawn from the water; joints very short,	66
p.	Flaccid and silky; joints longer,	65
q.	Dark; tips with tufts of roseate fibrils,	64
q.	Full red; in small dense tufts or wads which adhere closely to paper,	63
q.	Coarser; less densely tufted; scarcely adhering,	62
r.	Red brown; branches long, twig-like, sometimes with pencils of fine rosy branchlets; stem scarcely adhering to paper,	67
r.	Dull, brownish; tips fibrilliferous; joints striate; adhering to paper,	68
r.	Brighter colored, more branched and with longer joints,	69
s.	Pinnately much branched, scarcely jointed; branches mostly naked below and pinnate above; blackish; substance rigid and wiry, not adhering closely to paper; excessively variable,	73
s.	Internodes long; branches feathery at the tips; adheres to paper; a deep water variety of No. 73 (?)	74

s.	Forming globose, rigid, dark brown tufts on Fucus nodosus; joints mostly short, with a dark central spot, ...	75
s.	Small, rigid, full red, distichous, many times pinnate, with subulate pinnules, ...	71
s.	With none of the above combinations of characters, ...	t
t.	Dichotomous or zigzag; bright purplish, adhering to paper, .	70
t.	Densely tufted; not dichotomous; full red; scarcely adhering .	72
u.	River mouths, etc., sometimes in fresh water, ...	76
v.	Bright red, closely adhering to paper, ...	77
w.	Shallow water, etc.; adheres to paper; variable, ...	78
x.	Lurid purple; green when exposed, white when bleached, . .	79
y.	Others probably occur; S. T. Olney mentions No.	80
z.	Common on the Mass. coast; said by Mr. Bicknell to be No. .	81
A.^{2}	Brilliant, very delicate; adhering closely, ...	82
B.^{2}	Fronds like oak-leaves; pinnatifid or sinuate; deep water, . .	83
B.^{2}	Alternately or dichotomously branched; roseate, ...	84
B.^{2}	Frond undivided, proliferously branched from the midvein, . .	85
B.^{2}	Frond dichotomous; constricted, almost jointed at the nodes, rooting or proliferous at the forks; purple, ...	86
C.^{2}	Frond somewhat rigid; sori oblong, ...	87
C.^{2}	Frond soft, thin, flaccid; sori round, ...	88
D.^{2}	Dark red-purple; apices sometimes cirrhous, ...	89
E.^{2}	Much divided; conceptacles prominent; variable, ...	90
F.^{2}	Purplish; rather rigid, ...	91
G.^{2}	Dark or blood-red; adheres to paper; variable, ...	92
H.^{2}	Branches which bear tetraspores, pod-like in the middle, . .	93
I.^{2}	Very dark red-brown; does not adhere to paper, ...	94
J.^{2}	Red-black; margin paler, ...	95
K.^{2}	Dull purplish, adhering to paper, ...	96
L.^{2}	Rosy red; level-topped; tender, ...	97
M.^{2}	Tetraspores in cloudy patches; large; common, ...	98
M.^{2}	Tetraspores in distinct sori; small; rare, ...	99
N.^{2}	Bright crimson; scarcely adhering to paper, ...	100
O.^{2}	Lower branchlets entire; upper pectinate, ...	101
P.^{2}	Livid purple; sometimes compressed; densely tufted, ...	102
Q.^{2}	Tetraspores in excrescences (nemathecia) at the tips of the laminæ; clear red, ...	103
Q.^{2}	Nemathecia forming dark colored, convex patches at the centre of the laminæ; dull red, ...	104
R.^{2}	Compressed; segments forked at tips, ...	105
R.^{2}	Flat; axils very much rounded, ...	106
S.^{2}	Densely tufted; wiry; does not collapse, ...	107
T.^{2}	Fruiting branches mostly tapering to base; excessively variable,	108
U.^{2}	Bright red; palmate; rare, ...	109
V.^{2}	Dark red; rigid and dichotomous, ...	110
W.^{2}	Often iridescent; greenish in shallow water and bleaching to white; sori purplish, like drops of blood; common, . . .	111
X.^{2}	Much divaricate; branches tubular, ...	112

X.^{2} Pinnate; branches mostly opposite and compound, ... **113**
Y.^{2} Very densely tufted; often distorted; livid purple, ... **114**
Z.^{2} Similar, except in fruit, to Polyides, ... **115**
a.^{2} Frond multifid; laciniæ very long, ... **116**
a.^{2} Frond pinnately decompound, ... **117**
b.^{2} Much branched; older parts hollow, ... **118**
c.^{2} Branches spreading; covered with small branchlets, ... **119**
c.^{2} Branches straggling; often revolute; shorter and stouter, . . **120**
d.^{2} Internodes entirely diaphanous; surface cells only at the nodes, **e**^{2}
d.^{2} Coarser; internodes not entirely diaphanous; common and variable, ... **121**
e.^{2} Joints everywhere as long as broad; of a single colored cell; forming mats on rocks, ... **122**
e.^{2} Frond of equal diameter throughout; lower joints rosy; 4 to 6 times as long as broad; upper shorter, ... **124**
e.^{2} Attenuated above: lower joints 3–4 times as long as broad, . . **f**
f.^{2} Nodes swollen: internodes pellucid, ... **123**
f.^{2} Nodes not swollen: lower internodes striate, ... **125**
g.^{2} Pinnæ opposite, unlike; the one undivided leaf-like, the other branch-like pinnately-compound, ... **126**
g.^{2} Pinnæ opposite, mostly similar, ... **h**^{2}
h.^{2} Pinnæ articulated: dark purple: adheres to paper, ... **128**
h.^{2} Pinnæ unequal: northern: rare in America, ... **127**
i.^{2} Branchlets very numerous, incurved, ... **129**
j.^{2} Adheres closely to paper: common: variable, ... **130**
k.^{2} Frond shrub-like, pyramidal, with an excurrent main stem which is not obviously articulate, ... **l**^{2}
k.^{2} Frond shrub-like, or alternately decompound, with dichotomous branchlets: color *not* rose-purple: commonly drying pale or brown red, ... **o**^{2}
k.^{2} Fronds alternately decompound: a pair of minute opposite branchlets at each node; mostly brilliant, ... **p**^{2}
k.^{2} Branchlets few and distant, with whorls of opposite fibres at apex, ... **149**
k.^{2} Without above characters: an inch or more high, densely tufted, mostly rose-purple, and obviously jointed throughout, ... **m**^{2}
k.^{2} Frond ¼–1 inch, arising from creeping, matted threads, . . . **144**
k.^{2} Frond ¼ inch or less high: parasitic, not rising from matted threads, and mostly but slightly branched, ... **r**^{2}
l.^{2} Joints in branches twice as long as broad, ... **131**
l.^{2} Joints in branches 3–4 times as long as broad: nodes swollen, . **132**
m.^{2} Plumules fan-shaped, bare of branches in the lower half, . . . **133**
m.^{2} Pinnate: plumules with zigzag rachis: joints of branches 10 times as long as broad, ... **136**
m.^{2} Without above characters, ... **n**^{2}
n.^{2} Densely tufted: bright rose purple: filaments finer than human hair: joints 3–8 times as long as broad, ... **135**

n.^{2} Somewhat coarser, with shorter joints: plumules distichous, . 134
o.^{2} Slender, shrub-like, distinguished at once from other Callithamnia by the bead-like chains of fruit (seirospores): common, often greenish: (Formerly and perhaps more properly considered as the type of a separate genus, as *Seirospora Griffithsiana* Harv.), ... 138
o.^{2} Articulate throughout, branches ending in little corymbs of branchlets, ... 137
p.^{2} Branchlets pectinate, secund, recurved, on the upper side only of branches: a beautiful and rare little species: specimens of which were found at Penikese in 1873, by Miss Susan Bowen, ... 139
p.^{2} Branchlets simple, subulate, ... 142
p.^{2} Branchlets, or some of them in fours, pinnate, ... 143
p.^{2} Without above characters; branchlets opposite, pinnate, or bipinnate, ... q^2
q.^{2} Joints 4–10 times as long as broad: brilliant: frequent, . . . 140
q.^{2} Joints shorter: less common, ... 141
r.^{2} Forming a dense purple fringe on Zostera: branches long, secund, ... 145
r.^{2} Forming crimson patches on rocks: branches long, erect, . . 146
r.^{2} Forming velvety tufts on Dasya: branches bud-like, secund, . 147
r.^{2} Forming a fleecy, pink-down on Ceramium rubrum: branches spreading, curved: frequent, ... 148

54. Odonthalia dentata Lyngby. Maine and North. 3–12.
55. Chondria dasyphylla Agardh. Coast. 6–12.
56. Chondria Baileyana Montagne. Coast. 6–8.
57. Chondria tenuissima Agardh. Boston to New York. 4–6.
58. Chondria atropurpurea Harvey. South Carolina and South. 4–10.
59. Rhodomela subfusca Agardh. New Jersey and North. 6–12.
60. Rhodomela gracilis Kützing. Massachusetts and North. 4–12.
61. Rhodomela Rochei Harvey. New Jersey to Massachusetts. 4–8.
62. Polysiphonia urceolata Greville. Virginia and North. 6–12.
63. Polysiphonia formosa Suhr. New Jersey and North. 4–8.
64. Polysiphonia subtilissima Montagne. New Jersey and North. 2–4.
65. Polysiphonia Olneyi Harvey. Long Island and North. 3–5.
66. Polysiphonia Harveyi Bailey. Boston to New Jersey. 2–4.
67. Polysiphonia elongata Greville. Massachusetts, etc. 6–12.
68. Polysiphonia fibrillosa Greville. New Jersey to Massachusetts. 5–8.
69. Polysiphonia violacea Greville. New York and North. 6–82.
70. Polysiphonia variegata Agardh. Coast. 2–8.
71. Polysiphonia parasitica Greville. Rhode Island, etc. 1–3.
72. Polysiphonia atrorubescens Greville. New Jersey to Rhode Island. 1–4.
73. Polysiphonia nigrescens Greville. Coast. 3–15.
74. Polysiphonia affinis Moore. Coast. 4–12.
75. Polysiphonia fastigiata Greville. New York to Halifax. 1–2.
76. Bostrychia rivularis Harvey. New York to Florida. ½–1.
77. Dasya elegans Agardh. Cape Cod and South. 6–36.
78. Champia parvula Harvey. Cape Cod and South. 2–4.
79. Corallina officinalis L. New Jersey and North. 2–4.
80. Melobesia pustulata Lamouroux. Rhode Island, etc.
81. Nullipora polyphyllamea (?). New York and North. (A. Melobesia?)

82. Grinnellia Americana Harvey. New Jersey to Massachusetts. 4–24.
83. Delesseria sinuosa Lamouroux. New York and North. 3–8.
84. Delesseria alata Lamouroux. Cape Cod and North. 2–6.
85. Delesseria Hypoglossum Lamouroux. Virginia and South. 3–5.
86. Delesseria Le Prieurii Montagne. West Point and South. 1–2.
87. Nitophyllum laceratum Greville. Maine and North. 6–8.
88. Nitophyllum punctatum Greville. North Carolina and South. 2.
89. Calliblepharis ciliata Kützing. Massachusetts and North. 2–8.
90. Gracilaria multipartita Agardh. Coast. 6–12.
91. Gelidium corneum Lamouroux. Coast. 2–5.
92. Solieria chordalis Agardh. Cape Cod and South. 6–14.
93. Hypnea musciformis Lamouroux. Cape Cod and South. 4–8.
94. Polyides rotundus Greville. New York to Boston. 2–3.
95. Peyssonnelia imbricata Kützing. Newfoundland.
96. Nemalion multifidum Agardh. Long Island and North. 6–10.
97. Scinaia furcellata Bivona. Rhode Island and South. 2–4.
98. Rhodymenia palmata Greville. (*Dulse.*) Virginia and North. 6–18.
99. Rhodymenia Palmetta Greville. Halifax. 1–3.
100. Euthora cristata Agardh. Cape Cod and North. 1–3.
101. Plocamium coccineum Lyngby. Massachusetts. 3–5.
102. Cordylecladia (?) Huntii Harvey. Rhode Island. 2–3.
103. Phyllophora Brodiei Agardh. Cape Cod and North. 3–4.
104. Phyllophora membranifolia Agardh. Cape May and North. 3–4.
105. Gymnogongrus Torreyi Agardh. New York 4–7.
106. Gymnogongrus Norvegicus Agardh. Maine. 2–3. Lynn Beach.
107. Ahnfeltia plicata Fries. New Jersey and North. 5–10.
108. Cystoclonium purpurascens Kützing. Cape May and North. 6–14.
109. Callophyllis laciniata Kützing. Delaware. 3–6.
110. Gigartina mamillosa Agardh. Cape Coast and North. 3–6.
111. Chondrus crispus Lyngby. (*Irish Moss.*) New Jersey and North. 3–8.
112. Chylocladia Baileyana Harvey. Cape Cod and South. 2–3.
113. Chylocladia rosea Harvey. Long Island to Maine. 1–2.
114. Halosaccion ramentaceum Ag. New Hampshire and North. 10–14.
115. Furcellaria fastigiata Lyngby. Newfoundland. 4–8.
116. Grateloupia Gibbesi. Harvey. South Carolina. 6–20.
117. Grateloupia filicina Agardh. Georgia and South. 6–12.
118. Gloiosiphonia capillaris Carmichael. New England. 4–6.
119. Spyridia filamentosa Harvey. Coast. 3–10.
120. Spyridia filamentosa var. refracta Harvey. Massachusetts to Florida. 3–8.
121. Ceramium rubrum Agardh. South Carolina to Greenland. 2–10.
122. Ceramium Hooperi Harvey. Cape Cod, North. 1–2.
123. Ceramium diaphanum Roth. Boston, South. 2–4.
124. Ceramium fastigiatum Harvey. Virginia to Maine. 2–4.
125. Ceramium arachnoideum (?) Agardh. New Jersey to Massachusetts. 1–2.
126. Ptilota serrata Kützing. Cape Cod and North. 4–6.
127. Ptilota plumosa Agardh. Halifax, North. 4–6.
128. Ptilota elegans Bonnemaison. Boston, South. 3–6.
129. Halurus equisetifolius Kützing. New York (?) 6–8.
130. Griffithsia corallina Harvey. Boston, South. 3–6.
131. Callithamnion tetragonum Agardh. New England. 3–4.
132. Callithamnion Baileyi Harvey. New York to Massachusetts. 2–3.
133. Callithamnion Borreri Agardh. New York to Cape Cod. 1–3.
134. Callithamnion polyspermum Agardh. New York and South. 2–3.
135. Callithamnion byssoideum Arn. New Jersey to Massachusetts. 1–3.
136. Callithamnion Dietziæ Hooper. Long Island. 2–3.
137. Callithamnion corymbosum Agardh. New York and North. 2–3.
138. Callithamnion seirospermum Griffiths. New York to Maine. 3–5.
139. Callithamnion plumula Lyngby. Long Branch and Penikese, 1–2.

140. CALLITHAMNION AMERICANUM Harvey. New York and North. 3-4.
141. CALLITHAMNION PYLAISEI Montagne. Cape Cod and North. 3-4.
142. CALLITHAMNION FLOCCOSUM Agardh. Massachusetts. 4-6.
143. CALLITHAMNION CRUCIATUM Agardh. New York. 1-1½.
144. CALLITHAMNION TURNERI Agardh. Coast. ½-1.
145. CALLITHAMNION LUXURIANS Agardh. New York and North.—
146. CALLITHAMNION ROTHII Lyngby. Connecticut.—
147. CALLITHAMNION VIRGATULUM Harvey. New York.—
148. CALLITHAMNION DAVIESII Agardh. Massachusetts.—
149. CALLITHAMNION TENUE Harvey. New Jersey. 3-4.

PART III. CHLOROSPERMEÆ.

(GREEN ALGÆ.)

PLANTS grass-green, rarely brownish, bluish or purple, a few low forms red. Propagation in our species by simple cell-division, or by transformation of the coloring matter (endochrome) of the cells of the whole or a part of the frond, into zoospores. In all waters and damp places.* **A**

A. *Fronds filamentous, articulated; endochrome diffused: spores small.* . . . . . . CONFERVACEÆ. **H**

A. *Fronds various, never truly jointed.* . . . . **B**

B. *Frond tubular and hollow often branched or else broad and flat, membranous, composed of simple quadrate cells.* **C**

B. *Fronds composed of a simple filiform often profusely branching cell, or of many such cells united into a sponge-like body; often bright green and plume-like.* SIPHONACEÆ. **E**

B. *Frond with an annulated pith, composed of very short cellules, surrounded by a membranous, inarticulate, tubular sheath.* . . . . OSCILLATORIACEÆ. **I**

B. *Microscopic, unicellular; growth by semisection of the cell.* **D**

C. *Color bright green at all times.* . . . . . ULVACEÆ. **G**

C. *Olivaceous or purplish, becoming bright purple when dry or in fruit.* . . . . PORPHYRACEÆ. **F**

---

* For descriptions of our numerous fresh water Chlorosperms and for a more recent arrangement of families than the one here adopted, see Prof. H. C. Wood's excellent "Contributions to the History of the Fresh Water Algæ of North America."

D. *Green — cell-walls membranous; fresh water — chiefly or entirely.* . . . . DESMIDIACEÆ.*

D. *Yellow brown; cell-walls silicious.* DIATOMACEÆ.*

E. Frond sponge-like, of densely interwoven filaments, . *Codium.* **J**
E. Filaments free, plume-like, pinnately branched, . . *Bryopsis.* **L**
E. Filaments numerous, tufted or matted at base, free above, irregularly branched, ... *Vaucheria.* **K**
F. Frond tubular, ... *Bangia.* **N**
F. Frond flat, simple or cleft, ... *Porphyra.* **M**
G. Frond flat, sometimes saccate while young, ... *Ulva.* **Q**
G. Frond tubular, often branched, ... *Enteromorpha.* **O**
H. Filaments tufted, branched, ... *Cladophora.* **S**
H. Filaments unbranched; nodes not constricted, . *Chætomorpha.* **b**
H. Filaments unbranched; constricted at the nodes; joints very short, ... *Hormotrichum.* **f**
I. Filaments long, flexible, bundled together, ... *Lyngbya.* **g**
I. Filaments short, tufted, erect, fixed at base, . . . *Calothrix.* **l**
I. Filaments rigid, needle-shaped, lying loosely in a mucous matrix; vividly oscillating; commonly floating, . . *Oscillatoria.**
J. Fronds erect, dichotomous, clothed with soft hairs, ... **149**
K. Not much branched; cell walls thin, ... **150**
L. Common and variable; with a bright glassy lustre when dry, . **151**
M. Fruit — minute dark purple granules, arranged in fours, . . . **152**
N. In fresh or salt water forming large dark purple patches, . . . **153**
N. Forming a minute rosy down on Chondria, etc., ... **154**
O. Frond never branched, large and bag-like when fully grown, . **155**
O. Frond branched; branches simple, obtuse, ... **156**
O. Frond branched; branches beset with branchlets, ... **P**
P. Fronds slender, tufted, ... **157**
P. Fronds very fine and feathery; branchlets articulated, conferva-like, ... **158**
Q. Membrane formed of a double layer of cells; . . . . **R**
Q. Membrane formed of a single layer of cells; semi-transparent; frond very delicate, saccate while young, becoming cleft; adheres closely to paper, ... **161**
R. Frond lanceolate, composed of two closely applied membranes; adheres to paper, ... **159**
R. Frond polymorphous, flat, smooth and glossy; common, . . **160**
S. Filaments rigid, dark green tufted, cell walls thick; joints 3 to 4 times as long as broad, ... **162**
S. Filaments soft, forming dense, spongy fastigiate pale green tufts, **T**
S. Filaments loosely tufted, stout, scarcely collapsing when drawn from the water; vivid green; joints 3 to 6 times as long as broad, ... **a**

---

* Omitted.

S. Dull green, scarcely adhering to paper; branches few, spreading with wide axils; in brackish or fresh waters, ... 175

S. Not as above; filaments loosely tufted sometimes interwoven, feathery, very slender; pale or bright green, ... V

T. Joints below about twice—above, 6 to 8 times as long as broad, U

T. Joints uniformly about twice as long as broad; tufts short, globose 165

U. Tufts starry, of a brilliant glossy green retained in drying, . . 163

U. Tufts globose small, yellow-green; on small algæ, ... 164

V. Joints 6 to 10 times longer than broad; bright yellow-green, . 171

V. Joints 3 to 5 times longer than broad; pale or yellow-green; not adhering closely to paper, ... Z

V. Joints 2 to 4 times as long as broad; mostly adhering to paper, W

W. Dark or brilliant green (often drying pale); nodes not constricted; excessively branched, ... Y

W. Pale or glaucous green; nodes mostly constricted, ... X

X. Excessively branched; ultimate divisions secund-pectinate; joints uniformly three times as long as broad, ... 166

X. Less branched, with longer joints; main branches long, flexuous, almost naked, ... 167

Y. Rather rigid; branches recurved-pectinate; joints 2 to 4 times as long as broad, ... 169

Y. Stems long, flexuous; branches long, with short branchlets; joints shorter, ... 168

Z. Pale greenish, forming spongy tufts; nodes slightly constricted, 170

Z. Yellow green; very flexuous; forming silky tufts, ... 172

a. Bright yellow green, fading when dry: branches crowded, . . 173

a. Full green; branches distant, nearly naked, ... 174

b. Joints 3 or more times as long as broad, ... c

b. Joints 1½ to 3 times as long as broad, ... d

b. Joints not longer than broad, yellowish, rather rigid but collapsing when drawn from the water, ... 178

c. Very rigid, glossy green; not adhering to paper; deep water, 176

c. Pale and flaccid; nodes very long, swollen, pale green, . . . 180

d. Soft and flaccid; adhering closely to paper, ... 179

d. Coarse and rigid, dark green; filaments straight, ... 177

d. Filaments twisted, very slender but somewhat harsh, ... e

e. Mostly floating; joints less than twice as long as broad, . . . 181

e. On rocks, etc., joints twice as long as broad or more, ... 182

f. Joints about as long as broad; substance rather firm, ... 183

f. Joints twice as broad as long, substance rather soft, ... 184

g. Cell walls thick, ... h

g. Cell walls thin, ... i

h. In large dark green tufts; filaments thick and tenacious, . . . 185

h. On rocks, etc., rusty or olivaceous; filaments upright in the water, 187

i. Northern species, floating in mats in stagnant salt waters or spreading in thin strata on mud, ... j

i. Southern, blackish green, floating or attached to small algæ, . k
j. Bluish green or rusty red; filaments tenacious, ... 186
j. Blackish green or violaceous; filaments not half so stout as in the preceding. 188
k. Filaments 1 to 2 inches long; scarcely interwoven; the endochrome not very distinctly annulated. 189
k. Minute; filaments densely matted together; annulations more distinct. 190
l. In little starry tufts on the smaller algæ. 191
l. In velvety patches on rocks, etc. . . . . m
m. Filaments flexuous, simple; common on rocks, rendering them very slippery. 192
m. Filaments longer and straighter, often appearing branched, by the splitting of the endochrome ("viviparous"), ... 193

150. CODIUM TOMENTOSUM Stackh. Florida. 3–24.
151. VAUCHERIA (species undescribed in Phycologia Brittanica, allied to V. marina) Buzzard's Bay, etc. 2–3.
152. BRYOPSIS PLUMOSA Lamouroux. Massachusetts and South. 3–6.
153. PORPHYRA VULGARIS Agardh. Charleston and North. 2–10.
154. BANGIA FUSCOPURPUREA Lyngby. New Jersey and North. 2–3.
155. BANGIA CILIARIS Carmichael. South Carolina. One-tenth.
156. ENTEROMORPHA INTESTINALIS Link. Whole Coast. 3–10.
157. ENTEROMORPHA COMPRESSA Greville. Whole Coast. 3–8.
158. ENTEROMORPHA CLATHRATA Greville. Cape May and North. 2–6.
159. ENTEROMORPHA HOPKIRKI M'Calla. New York, Massachusetts. 3–4.
160. ULVA (PHYCOSERIS) LINZA Linnæus. New Jersey and North. 6–12.
161. ULVA (PHYOCSERIS) LATISSIMA Linnæus. Whole Coast. 6–24.
162. ULVA LACTUCA Linnæus. Massachusetts, Texas. 6–12.
163. CLADOPHORA RUPESTRIS Linnæus. Maine and North. 2–8.
164. CLADOPHORA ARCTA Dillwen. New Jersey and North. 2–3.
165. CLADOPHORA LANOSA Roth. Massachusetts. 1–1½.
166. CLADOPHORA UNCIALIS Flora Danica. Cape Cod and North. 1.
167. CLADOPHORA GLAUCESCENS Griffiths. Whole Coast. 3–5.
168. CLADOPHORA FLEXUOSA Griffiths. New Jersey and North. 3–5.
169. CLADOPHORA MORRISIÆ Harvey. Delaware. 6–8.
170. CLADOPHORA REFRACTA Roth. Whole Coast. 2–3.
171. CLADOPHORA ALBIDA Hudson. New York, Massachusetts. 6–8.
172. CLADOPHORA RUDOLPHIANA Agardh. New York. 4–5.
173. CLADOPHORA GRACILIS Griffiths. New York-Maine. 4–12.
174. CLADOPHORA LÆTEVIRENS Dillwen. Coast. 3–8.
175. CLADOPHORA DIFFUSA (?) Harvey. New York. 6–12.
176. CLADOPHORA FRACTA Flora Danica. New Jersey–Massachusetts. 4–8.
177. CHÆTOMORPHA PIQUOTIANA Montagne. New Jersey and North. 12–16.
178. CHÆTOMORPHA MELAGONIUM Web. and Mohr. New York and North. 5–12.
179. CHÆTOMORPHA ÆREA Dillwen. New Jersey–Massachusetts. 3–12.
180. CHÆTOMORPHA OLNEYI Harvey. Rhode Island and Massachusetts. 3–10.
181. CHÆTOMORPHA LONGIARTICULATA Harvey. New England. 3–4.
182. CHÆTOMORPHA SUTORIA Berkeley. Connecticut. 3–8.
183. CHÆTOPHORA TORTUOSA Dillwen. Cape Cod and North. 3–4.
184. HORMOTRICHUM YOUNGANUM Dillwen. Cape May–Cape Cod. 1–3.
185. HORMOTRICHUM CARMICHÆLI Harvey. Boston and North. 1–3.
186. LYNGBYA MAJUSCULA Harvey. Whole Coast. 1–2.
187. LYNGBYA FERRUGINEA Agardh. Coast. 1–2.

188. Lyngbya fulva Harvey. Connecticut. 1-2.
189. Lyngbya nigrescens Harvey. New Jersey–Massachusetts. 1.
190. Lyngbya confervoides Agardh. South Carolina. 1-2.
191. Lyngbya pusilla Harvey. South Carolina. ½.
192. Calothrix confervicola Agardh. Coast. One-tenth.
193. Calothrix scopulorum Agardh. Coast. One-twentieth.
194. Calothrix vivipara Harvey. Long Island to Massachusetts. **Three-tenths.**

ADDITIONS.

Dr. W. G. Farlow in Professor Baird's "Report on Fish and Fisheries, 1873," gives the following additional species, localities, etc.: —

Ralfsia verrucosa Ag. Little Nahant — only known station in America.

Myriotrichia filiformis Griff. Point Judith.

Fucus distichus L. Marblehead.

Fucus furcatus L. Massachusetts Coast.

Melobesia polymorpha L. Robbinstown, Mass.

Melobesia membranacea Lam. Common along the coast on Zostera.

Melobesia pustulata Lam. On Fuci, Chondrus, etc. Coast of Massachusetts.

Hildenbrandtia rubra. Wood's Hole to New Haven.

Gymnogongrus Norvegicus Grev. Lynn Beach.

A slender species of Gracilaria supposed to be *G. confervoides* Grev. picked up on Long Island.

Chrysimenia (Chylocladia) rosea Harvey. Gay Head.

Callithamnion plumula Lyngby. Gay Head. Orient Point.

Chondria littoralis Ag. Wood's Hole, Mass. (Key West. Harvey.)

Dr. Farlow regards *Sargassum Montagnei* as a variety of *S. vulgare*, and thinks *Callithamnion Baileyi* a warm water variety of *C. tetragonum.*

ETYMOLOGY OF NAMES OF GENERA.

Agarum *Bory St. Vincent.* A Mushroom(?)
Ahnfeltia *Ag.* For Ahnfelt, a German botanist.
Alaria *Grev.* Winged.
Arthrocladia *Duby.* Jointed branch (in "Key" Arthocladia, by error).
Asperococcus *Hooker.* Rough-seeded.

Bangia *Lyngb.* For Hoffman Bang, a Danish botanist.
Bostrychia *Mont.* Ox-hair.
Bryopsis *Lam.* Moss-like.

Calliblepharis *Kütz.* Beautiful eye-lashes.
Callithamnion *Lyngb.* Beautiful little shrub.
Callophyllis *Kütz.* Beautiful leaf.
Calothrix *Ag.* Beautiful hair.
Ceramium *Roth.* A pitcher (but the fruit is not pitcher shaped).
Chætomorpha *Kütz.* Bristle-form.
Champia *Desv.* A personal name.
Chondria *Ag.* Cartilaginous.
Chondrus *Stackhouse.* Cartilage.
Chorda *Stackhouse.* A cord.
Chordaria *Agardh.* Cord like.
Chrysymenia *Ag.* A golden membrane.
Chylocladia *Greville.* Juicy branched.
Cladophora *Kützing.* Branch-bearing.
Cladostephus *Ag.* Branch-crowned.
Codium *Stackhouse.* Skin of an animal.
Corallina *Linnæus.* A little coral.
Cordylecladia *Ag.* Cord-like branches (?)
Cystoclonium *Kütz.* Bladdery branches.

Dasya *Ag.* Hairy.
Delesseria *Lamouroux.* For Baron Delessert, a French botanist.
Desmarestia *Lam.* For Desmarest, a French naturalist.
Dictyosiphon *Lyngby.* Netted tube.

Ectocarpus *Lyngb.* External fruit.
Elachista *Duby.* Smallest.
Enteromorpha *Link.* Intestine-shaped.
Euthora *Ag.*

Fucus *L.* Greek—a sea-weed.
Furcellaria *Lam.* Forked.

Gelidium *Lam.* Ice-like or jelly-like.
Gigartina *Lam.* A grape-seed (from the shape of the tubercles).
Gloiosiphonia *Carmichael.* Viscid-tubed.
Gracilaria *Grev.* Slender.
Grateloupia *Ag.* For Dr. Grateloup, a French algologist.
Griffithsia *Ag.* For Mrs. Griffiths, "the most distinguished of British algologists."
Grinnellia *Harvey.* For Henry Grinnell, of New York.

Gymnogongrus *Martius*. Naked warts.

Halidrys *Lyngby*. Sea-oak.
Halosaccion *Kütz*. Sea-bag.
Halurus *Kütz*. Sea-tail (?)
Hildenbrandtia *Nardo*. For Hildenbrandt.
Hormotrichum *Kütz*. Necklace-hairs.
Hypnea *Lam*. From Hypnum, a genus of mosses.

Laminaria *Lam*. From lamina, a plate or blade.
Leathesia *Gray*. For G. R. Leathes, a British naturalist.
Lyngbya *Ag*. For Hans Christian Lyngby, a noted Danish algologist.

Melobesia *Lam*. Name of a sea-nymph.
Mesogloia *Ag*. Viscid pith.
Myrionema *Grev*. Myriad threads.
Myriotrichia *Harvey*. Myriad hairs.

Nemalion *Tozzetti*. A crop of threads.
Nitophyllum *Greville*. Shining leaf.
Nullipora *L*. Without pores.

Odonthalia *Lyngb*. Toothed-branch.
Oscillatoria *Vaucher*. Oscillating.

Peyssonelia *Decaisne*. For J. Peyssonel, an algologist.
Phyllophora *Grev*. Leaf-bearing.
Plocamium *Lam*. Braided-hair.
Polyides *Ag*. Many-formed.
Polysiphonia *Grev*. Many-tubed.
Porphyra *Ag*. Purple.
Ptilota *Ag*. Pinnated.
Punctaria *Grev*. Dotted.

Ralfsia *Berkeley*. For John Ralfs, an English diatomist.
Rhodomela *Ag*. Red-black.
Rhodymenia *Grev*. A red membrane.

Sargassum *Rumph*. Sargazo in Spanish.
Scinaia *Bivona*.
Seirospora *Harvey*. Chain-seeds.
Solieria *Ag*. For Solière, a French algologist.
Sphacelaria *Lyngb*. Gangrened (from the withered fruiting tips).
Spyridia *Harvey*. Basket-like.
Stilophora *Ag*. Dot-bearing.
Striaria *Grev*. Striated.

Ulva *Linn*. Ul—water in Celtic.

Vaucheria *De Candolle*. For Vaucher, a Swiss confervologist.

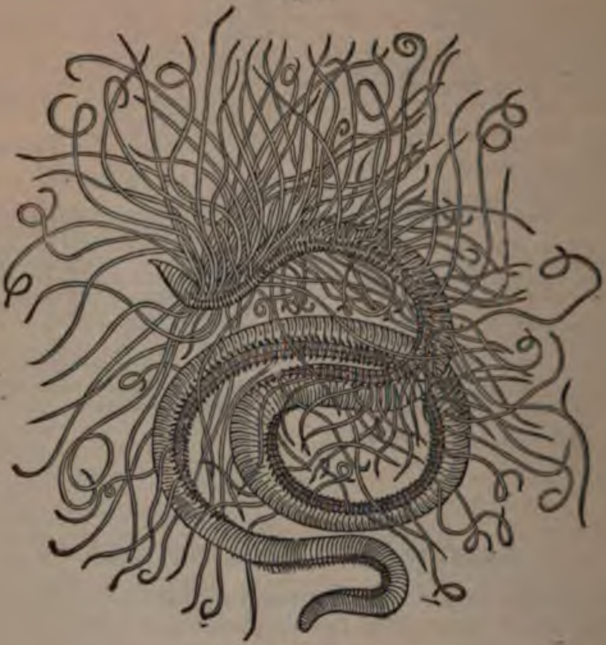
REVIEWS AND BOOK NOTICES.

THE UNITED STATES FISH COMMISSION REPORT.*—The valuable report of Prof. Baird, with the supplementary papers by Profs. Verrill, Gill, Smith and others, is not only a readable but exceedingly handy work for reference. How manifold are the subjects relating to a proper inquiry into the food and habits of our fishes may be gathered from the pages of this report. Not only have we full data concerning the practical questions relating to the fisheries, but Prof. Baird has called to his aid a number of naturalists, chemists and physicists, all whose investigations bear on the subject of our fisheries, the most abstruse matters having an immediate practical interest. It was thus found necessary to study the peculiarities in the temperature of the water at different depths, its chemical constitution, the percentage of carbonic acid gas and ordinary air, its currents, etc., besides thorough investigations with the dredge. The report relating exclusively to the fisheries occupies 280 pages of the volume, and is accompanied by woodcuts, diagrams, and a map designed to show more particularly the dis-

---

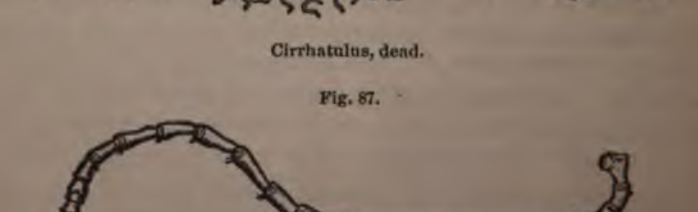
* United States Commission of Fish and Fisheries. Part 1. Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872. By Spencer F. Baird, Commissioner. With Supplementary Papers. Washington, 1873. 8vo. pp. 852, with a map and 40 plates. Verrill's Report separate. Naturalists' Agency. $3.00.

Fig. 85.



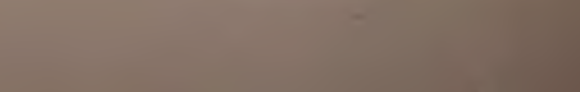
Cirrhatulus grandis, living.

Fig. 86.



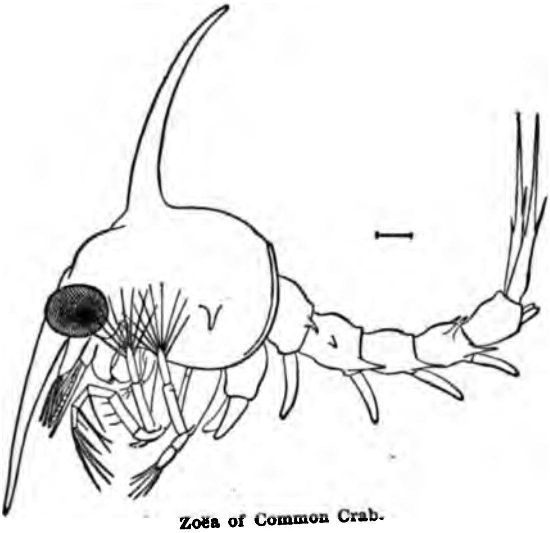
Cirrhatulus, dead.

Fig. 87.



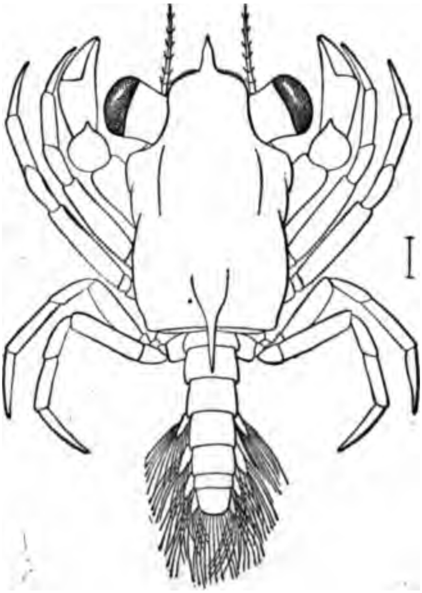
Clymenella.

Fig. 89.



Zoëa of Common Crab.

Fig. 90.



Megalops of Common Crab.

tribution of animal life along the coast of Rhode Island and Massachusetts south of Cape Cod.

The report is also accompanied by a "List of the Sea Weeds of the South Coast of New England," by Dr. W. G. Farlow; a "Report upon the Invertebrate Animals of Vineyard Sound and the Adjacent Waters, with an Account of the Physical Characters of the Region," by Prof. A. E. Verrill, and a "Catalogue of the Fishes of the East Coast of North America," by Dr. Theodore Gill.

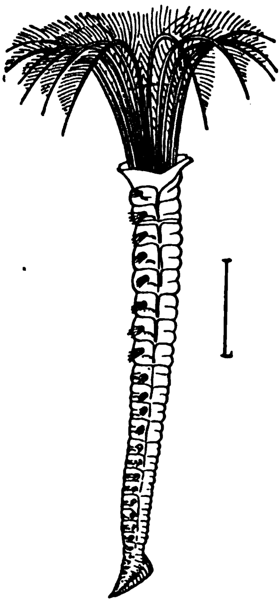
We shall concern ourselves chiefly with the admirable report of Prof. Verrill, which we would commend to our readers as a full and reliable manual of the marine zoology of our southern New England shore. It is illustrated by thirty-eight plates containing 287 figures (mostly drawn from life by Mr. Emerton) of the invertebrate animals, a few of them illustrating early stages of the crustacea. As an evidence of the thorough and detailed manner in which the subject is discussed, we may cite the chapters into which the work is divided:—Fauna of the Bays and Sounds; Fauna of the Brackish Waters of Estuaries, Harbors, etc.; Fauna of the Colder Waters of the Ocean Shores and Outer Banks and Channels; Lists of Species found in the Stomachs of Fishes; Habits and Metamorphoses of the Lobster and other Crustacea; Systematic Catalogue of the Invertebrates of Southern New England and Adjacent Waters. Under these heads will be found many remarks on the habits of the lower animals, which add much to the popular interest and value of the book.

A good many new forms are described and figured from life, mostly by Mr. Emerton, particularly among the worms and crustacea, and in the work of identifying and describing the latter, the author has been aided by Messrs. S. I. Smith and O. Harger. As samples of the illustrations, which are simple outlines by the Jewett process, we offer the following figures kindly loaned by the author. Fig. 84, *Lerneonema radiata* Stp. and Lüt., a copepod parasitic on the menhaden. Fig. 85 represents the *Cirrhatulus grandis* in a living state, and 86 the same from a specimen preserved in alcohol; Fig. 87, *Clymenella torquata*, Fig. 88, *Euchone elegans*.

We have in the July NATURALIST referred to the early history of the lobster described by Mr. Smith, and now reproduce his figures of the zoëa of the common crab (*Cancer irroratus*, Fig. 89, enlarged seventeen diams.) as seen in the last stage just before it changes to the "megalops" stage (Fig. 90, enlarged thirteen diams.).

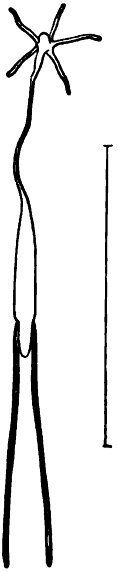
We shall look forward with much interest to the next year's report on the work done by the Fish Commission on the coast of Maine, preliminary notices of which have already appeared in the "American Journal of Science," the "Proceedings of the American Association" and this journal.

Fig. 88.



Euchone.

Fig. 84.



Lerneonema.

North American Flies.*—The long expected third volume of this series (the fourth was issued in 1869) has at length appeared. It contains elaborate monographs of two families of diptera entitled:—1. The family of Ortalidæ; 2. Review of the North American Trypetina.

The Ortalidæ are treated in the most exhaustive manner and the views about their classification, given in a long introductory

---

[*] Monographs of the Diptera of North America, Volume iii, prepared for the Smithsonian Institution, by H. Loew, Washington, 1873, 8vo, pp. 351.

chapter (pp. 1–70), embrace all the Ortalidæ at present known from all parts of the world. The existing literature of the Ortalidæ is also fully reviewed. The number of the North American species of this family described in the body of the work is sixty-six.

The North American Trypetidæ have been the subject of a monograph which appeared in the first volume of the same series (1860). The additions to this family, received by Mr. Loew since that publication, were so numerous that he thought it worth while to return to the same subject again. The present work contains the descriptions of sixty-one North American Trypetidæ, thirty-eight of which were not contained in his first monograph. To this are added twelve South American species, for the sake of comparison with closely allied North American ones.

To the volume are added four plates, with 116 figures, representing the wings of nearly all the described species.

The translation of the volume from the German manuscript was made by Baron R. Osten Sacken. The four volumes of the *Monographs*, etc., hitherto published, contain the following families of Diptera: Large monographs; Dolichopodidæ (Vol. II), Tipulidæ brevipalpi (Vol. IV), Ortalidæ (Vol. III), Trypetidæ (Vols. I and III). Smaller monographs (all in Vol. I): Sciomyzidæ, Ephydridæ, Cecidomyidæ.

THE UNICELLULAR NATURE OF THE INFUSORIA.[*] — Anything that comes from the pen of the distinguished professor of Jena is striking and original. The main idea of the present paper is a reaffirmation of the unicellular nature of the Infusoria, first distinctly enunciated by Von Siebold in 1845, when he opposed Ehrenberg's well known conceptions of their organization. Hæckel divides the animal kingdom into two groups, the one-celled or Protozoa, and the many-celled or Metazoa, and accompanies his views with the inevitable phylogenetic table of the animal kingdom.

This view scarcely seems in accordance with known facts regarding the structure of these so-called unicellular infusoria. If the reader will turn to that remarkable book, "Mind and Nature" (p. 43) by the late Professor H. J. Clark, he will find the many-celled structure of Actinophrys clearly described and figured. He remarks that "though the cells are very distinct, they exhibit a low state of development, as low perhaps as could possibly obtain without failing to be genuine cells." Farther on (p. 46) he claims that in this animal there are "two distinct sets of tissues," and speaks of an "outer layer of cells" and of a set of "inner cells." Until these parts are explained away we shall doubt the wisdom of the conclusions of the German observer, and call in question the naturalness of his classification of the animal kingdom into one-celled and many-celled animals. It seems less natural than the old division into vertebrates and invertebrates.

---

[*] Zur Morphologie der Infusorien; von Ernst Hæckel. From the Jena Zeitschrift. Bd. vii. Leipzig, 1873. 8vo, pp. 54, with two plates.

SIEBOLD'S ANATOMY OF THE INVERTEBRATES.[*] — We have constantly used this work, having found it the most valuable book of reference in the language, notwithstanding the fact that it is twenty years behind the times, and the classification is objectionable. This edition is exactly the same as that of 1854.

BOTANY.

Dr. **BEARDSLEE** has recently published a catalogue of the plants of Ohio, in the preface of which he speaks of "the late M. S. Bebb, of Illinois." As inquiries are already addressed to us upon the subject, we wish to say that Mr. Bebb actually and actively lives, and we hope the day is far distant when this appellation can be rightfully appended to the name of this most enterprising and efficient of our middle-aged western botanists. — A. G.

DOUBLE THALICTRUM. — A day or two ago, Mr. Whiting, a student, brought me a novelty in the shape of a completely doubled flower of *Thalictrum anemonoides*. The stamens were *all* transformed to pink petals, giving to the flower much the appearance of a small specimen of the double flowered form of *Prunus nana*. There was but one flower, on a solitary pedicel, otherwise the plant seemed to be normal. I shall secure the root if possible, and hope to perpetuate this very pretty sport. Is this doubled pink form common? — C. E. BESSEY.

Dr. W. G. **FARLOW**, a valued contributor to the NATURALIST, has returned to Cambridge, after two years' study of lower cryptogamic botany with DeBary of Strasburg, Müller of Geneva, and Thuret of Antibes. Through the month of August he takes charge of the summer botanical instruction at the Botanic Garden of Harvard University, which is for this month devoted to cryptogamic botany exclusively, mainly to Fungi and Algæ. We understand that he is engaged in the preparation of a manual of our New England Marine Algæ, which, for a beginner, is very much needed.

---

[*] Anatomy of the Invertebrata. By C. Th. von Siebold. Translated from the German with additions and notes by Waldo I. Burnett, M.D. Boston, 1874. James Campbell. 8vo, pp. 470. $5.00.

ZOOLOGY.

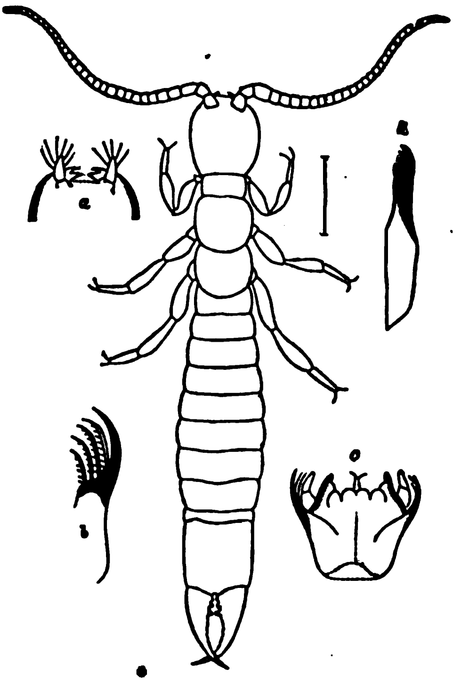
New Species of North American Bird. — On investigation of the interesting sandpiper from the Prybelov Islands, lately mentioned by Mr. Dall in the Naturalist (vii, 1873, 634) as *Tringa "crassirostris,"* and given under this name in my "Check List" (No. 426 *bis* upon Mr. Harting's identification, I found that the bird is not *T. crassirostris* but an apparently new species, which, in my late appendix to H. W. Elliott's Report on the Prybelov Islands (1873), I have named *Tringa ptilocnemis.* As the work just mentioned is not generally accessible, owing to the smallness of the edition, the following is reproduced in substance: —

Adult in breeding plumage. With somewhat the general appearance of *Tringa alpina*, but the black areas on the under parts pectoral, not abdominal. . . . Legs very short (much as in *T. maritima*); tibial feathers reaching nearly or quite to the suffrago. Tarsus shorter than the bill, or than the middle toe and claw. . . . A coronal area, upper back, interscapular region and scapulars black, completely variegated with rich chestnut-brown, paler ochrey-brown and whitish; the body of each feather being black with one or another or all of these various edgings; the coronal separated from the interscapular markings by a grayish-white, dusky-streaked, cervical interval. Lower back, rump and upper tail coverts blackish-brown, only varied with an occasional chestnut-edged feather. Wing coverts grayish-brown with narrow white edging, the greater ones with broad definitely white tips. Secondaries nearly all pure white, a few of the outermost and innermost also, with grayish-brown touches near the end. Primaries grayish brown with white shafts, except at tip, and fading to white on the inner webs toward the base; several of the innermost also largely white on the outer web, with definite white tipping. Central tail feathers brownish-black; next pair abruptly paler, grayish; rest white or nearly so, with a faint gray tint. Front and sides of head, supraciliary line, tufts of flank feathers and entire under parts white, interrupted on the breast with a large but not perfectly continuous nor well-defined black area, and marked on the upper breast and sides with a few narrow sharp blackish shaft lines. A dusky auricular patch. Legs and bill dark. Length about 9·50 inches; wing, about 5; tail, 2½; bill, 1·10 to 1·40; tarsus, 0·90 to 1·00; middle toe and claw 1.05 to 1.20.

The other plumages, a series of measurements, general discussion and description of eggs, with biographical notes by Mr. Elliott, will be found in his report. — Elliott Coues.

Occurrence of Japyx in the United States. — While engaged at the end of April in exploring the Mammoth Cave and adjoining caverns with Prof. Shaler of the Kentucky Geological Survey, I detected under a stone in a small cave a few rods north of White's Cave (which may be called White's Cave, Jr.) and from 40 to 50 feet from the mouth, consequently in partial daylight, a specimen of Japyx in company with two *Scolopendrella Americana* Packard, our most interesting myriopod, and not hitherto found except in Salem, Massachusetts. I afterward found several of the Japyx under stones by the roadside near Mammoth Cave. It here occurred, just as I have found the European *J. solifugus* near Vienna, in company with my friend Dr. Brauer. Our species differs decidedly from the European species, with specimens of which I have compared it (see Fig. 91, and details of mouth-parts). It is quite different from the Mexican *J. Saussurii* of Humbert from Santa Cruz and Orizaba.

Fig. 91.



Japyx solifugus.

Japyx subterraneus, as this new species may be called, may at once be distinguished from the other species by the much greater length of the abdomen, the head and thorax taken together being more than twice contained in the abdomen, while in *J. Saussurii* they are two-thirds as long as the abdomen. The 8th abdominal segment, also, is nearly twice as long as in the Mexican species. The head is broader than in *J. Saussurii*, but narrower and pointed a little more than in *J. solifugus*. The forceps are much nearer *J. solifugus* than the Mexican species, and is much longer than in either species. Length ·58 inch; the Mexican specimen measured about an inch. It is whitish, with the two terminal segments honey yellow; the forceps much darker. We shall in a succeeding number figure this interesting form, which is of extraordinary interest, as it is an ally of Campodea, now regarded as a stem-form of the higher insects by Brauer, Lubbock and others.—A. S. PACKARD, Jr.

THE "HATEFUL" GRASSHOPPER IN NEW ENGLAND.—Though the ravages by grasshoppers in New England are caused by the red-legged locust (*Caloptenus femur-rubrum*), it seems that for several years there have been specimens of *Caloptenus spretus* from Maine and Massachusetts in the Museum of the Peabody Academy of Science. They have been hitherto confounded with *C. femur-rubrum*, but are at once distinguishable by the shorter male cerci and the notched terminal ventral segment. The interesting fact about these eastern *C. spretus* is, that they are of precisely the same size and markings of *C. femur-rubrum*, being much smaller and with much shorter wings than the western race, a difference I believe due almost wholly to climatic causes. A number of surmises regarding sexual and natural selection and mimicry might be indulged in, but the facts that might suggest them can be explained by a reference to the different meteorological conditions by which the two races are environed. In Dr. Hayden's forthcoming "Annual Report on the Geology of Colorado," the reader will find a number of facts bearing on the variation in size of body, and form of wings and color in eastern and western examples of the same species of moths, the conclusions from which are borne out by a study of these grasshoppers.—A. S. PACKARD, Jr.

THE KINGLETS IN NEW JERSEY.—If your correspondent, Dr. Abbott, had only been aware that it has been our aim throughout our "History of North American Birds," to state nothing as *known* which is only *surmised* there would have been no occasion for any "surprise" on his part, that our account of the Reguli has been made to conform to this rule. It is never safe to infer from the mere presence of a bird in any particular locality in the breeding season that it necessarily breeds there. I could give you instances without number where birds are found in summer in localities, where, so far as one can ever be sure of a negative, we know they do not breed. We have seen the black-poll warbler in eastern Massachusetts as late as the 10th of June. Yet who supposes it ever breeds here? Dr. Abbott's account escaped my notice, but I certainly could not have made it the occasion of any change in my statement that the Regulus was not then *known* to breed in the United States. I could only have referred to the interesting fact of its occurrence, as stated, as suggestive of its possibility. Nothing short of its actual nest and eggs would have justified me in speaking of its breeding as a certainty. — THOMAS M. BREWER.

ZOOLOGY IN BELGIUM. — The Belgium Academy has lately issued two large octavo volumes, as memorials of its hundredth anniversary. The second volume is of great interest to zoologists as it contains a review of the progress of zoology in Belgium, by the veteran naturalist Prof. P. J. Beneden.

GEOLOGY.

SMALL SIZE OF THE BRAIN IN TERTIARY MAMMALS. — At the last meeting of the Connecticut Academy of Arts and Sciences, June 17th, Prof. Marsh made a communication on the size of the brain in Tertiary Mammals. His researches on this subject have been mainly confined to the larger extinct mammals which he had obtained in the Rocky Mountain region, and the results are of peculiar interest. The Eocene mammals all appear to have had small brains, and in some of them the brain cavity was hardly more capacious than in the higher reptiles. The largest Eocene mammals are the *Dinocerata*, which were but little inferior to the elephant in bulk. In *Dinoceras* Marsh, the type genus, the brain cavity is not more than one-eighth the average size of that in existing Rhinoceroses. In the other genera of this order, *Tinoceras* Marsh and *Uintatherium* Leidy, the smallness of the brain was quite as remarkable. The gigantic mammals of the American Miocene are the *Brontotheridæ*, which equalled the *Dinocerata* in size. In *Brontotherium* Marsh, the only genus of the family in which the skull is known, the brain cavity is very much larger than in the

Eocene *Dinoceras*, being about the size of the brain in the Indian Rhinoceros. In the Pliocene strata of the West, a species of Mastodon is the largest mammal, and although but little superior in absolute size to Brontotherium, it had a very much larger brain, but not equal to that of existing Proboscidians. The Tapiroid ungulates of the Eocene had small brain cavities, much smaller than their allies, the Miocene *Rhinocerotidæ*. The Pliocene representatives of the latter group had well developed brains, but proportionally smaller than living species. A similar progression in brain capacity seems to be well marked in the equine mammals, especially from the Eocene *Orohippus*, through *Miohippus* and *Anchitherium* of the Miocene, *Pliohippus* and *Hipparion* of the Pliocene, to the recent *Equus*. In other groups of mammals, likewise, so far as observed, the size of the brain shows a corresponding increase in the successive subdivisions of the Tertiary. These facts have a very important bearing on the evolution of mammals, and open an interesting field for further investigation.

DEEP SEA SOUNDINGS. — The "Tuscarora," Commander Belknap, duly reached Honolulu from San Diego, California, having been engaged in taking deep-sea soundings. She made a straight passage, not deviating twenty miles on either side of a direct line drawn between the two ports. During the passage sixty-two soundings were made, at a distance of forty miles apart. The deepest sounding — the forty-ninth after leaving the coast — was found to be 3,054 fathoms, while the mean depth was 2,562 fathoms. At a distance of 600 miles from the American coast the depth was found to be 494 fathoms, and at 1,050 miles, 780 fathoms. The average temperature below 1,200 fathoms was found to be about thirty-five degrees Fahrenheit. From Honolulu to Japan sixty casts were taken at intervals of about 50 miles. In the first 95 miles from Honolulu, the depth increased at nearly 162 ft. to a mile, reaching 2,418 fathoms in lat. 21° N., long. 159° 20′ W. The average depth of all the casts taken during this voyage was 2,450 fathoms. Between the mountains (all but one of which are entirely submarine) the bed of the ocean was very level: the greatest depth was found at lat. 22° 44′ N., long. 168° 23′ E., 3,262 fathoms.

Bottom temperatures, as in other parts of the Pacific, range from 33°·2 F. to 34°·6 below 1,800 fathoms, whatever the additional depth. Between 1,200 and 1,800 fathoms the temperature rises slowly to about 35° at the former depth. From 1,200 fathoms to the surface the thermometer rose steadily; surface temperatures ranging from 70° to 76° F.

The voyage occupied twenty-eight days, and the weather was exceptionably favorable. There are only sixty-five inhabitants on Peele Island, and the "Tuscarora" was the first visit of a naval vessel for more than seventeen years; Commodore Perry stopped at the island in 1853.

ANTHROPOLOGY.

Troglodytes in Alaska.—In 1872, Mr. William H. Dall made some interesting discoveries of prehistoric remains in a cave on Amaknak Island, situated in Captain's Bay, Oonalaska, which he supposed exhausted the subject. In 1873, however, he found that he had left undisturbed a still lower stratum, and finally cleaned out the entire cave down to the bed rock. He ascertained that the whole interior of the cave had been painted over with a red pigment or chalky ore of iron, above which was a bed of organic mould about two feet in its greatest depth, in which were found three skeletons, surrounded by a rough sort of sarcophagus built of the jaws and ribs of whales, and around them were a large number of implements, especially of stone knives. This was covered in turn by a layer six inches or less in thickness of refuse material, the remains of repasts on marine animals, shell-fish, fish, and echini. Scattered irregularly over this were broken and worn implements of quite a different character from those found with the dead; and the whole indicated that this was only a resting-place of parties who used it temporarily while waiting an opportunity to cross the surf to the adjacent island. It was down to this lower stratum that the labors of the previous season had extended but without disturbing it.

A stratum of this latter portion was covered by a bed of shingle, evidently introduced by water, and supposed to be the actual bottom of the deposit. Mr. Dall is of the opinion that the skeletons found here are the oldest yet discovered in the Aleutian region, although not approaching in antiquity those discovered on Table Mountain, or the Neanderthal. He thinks the cave was first used as a burial-place, the mould over three skeletons having accumulated by the decay of animal matter and of rubbish; and that the débris from the repasts of occasional visitors had been gathering for a great many years. An unusually high tide or storm probably brought in the shingle from the adjacent sea-beach, and after this the cave was again used as a deposit for the dead. Nothing was discovered indicating in any way that the place had been used or visited by the white races.

The total number of crania obtained by Mr. Dall amounted to thirty-six, besides many hundred implements of bone, ivory, and stone, and many carvings of wood and other objects, presenting evidence of the existence of large and flourishing communities numbering thousands of inhabitants where now none or only remnants of population exist.

Underneath the old villages were found still more ancient kitchen heaps of echini, fish bones, and edible shell-fish many feet in thickness, the age and time taken in forming them hardly to be approximated or counted even in centuries. Only in the upper strata were seen the indications of progress in hunting and fishing, afterward so notable that even the sperm whale succumbed to the attacks of these hardy canoe-men. Their progenitors were content to pick echini from the shore and mussels from the rocks, and hardly any implements could be found in the refuse of their repasts—the accumulation of centuries.

After them large villages of solidly constructed houses rose; and probably at the height of their progress and numerical increase the almost equally barbarous Russian of Siberia fell upon them, and nearly swept them from the face of the earth.—*Harpers' Weekly.*

Egyptian Archæology.—At the meeting of the Anthropological Institute, June 9, Prof. Busk, F. R. S., president, in the chair, Sir John Lubbock, Bart., read a paper on the discovery of stone implements in Egypt. The author began with a sketch of the writings and opinions of M. Arcelin and Dr. Hamy, who maintained that the flint implements found along the valley of the Nile, including a hatchet of the St. Acheul type at Deir-el-Bahari, indicated the existence formerly of a true stone age there as in Western Europe. MM. Mortillet and Broca concurred in that view. On the other hand Dr. Pruner-Bey, and especially Dr. Lepsius, had expressed the opinion that most of the objects described, such as the flint flakes, were naturally produced. M. Chabas also took the same view as Dr. Lepsius, and denied the existence of any evidence of a stone age in Egypt or elsewhere. On the occasion of a late visit to Egypt with the object of getting conclusive personal evidence on the question, the author found worked flints at various spots along the Nile Valley, especially in the valley of the tombs of the kings of Thebes, and at Abydos, and after carefully weighing the facts and arguments brought forward by MM. Lepsius and Chabas, he was disposed to agree with MM. Arcelin and Hamy in considering that these flint implements really belonged to the stone age, and were ante-Pharaonic. Sir John exhibited a full series of the Egyptian flint implements found by himself during his visit. and the paper concluded with a minute description of each specimen. Prof. Owen, F. R. S., then read a paper on the ethnology of Egypt. Since the observations recorded in 1861, by Dr. Pruner-Bey, on the race-characters of the ancient Egyptians, mainly based on the characters of skulls, evidences, in the author's opinion, of a more instructive kind have been discovered, chiefly by M. Mariette-Bey. They consist of portrait-sculptures, chiefly statues, found in tombs accompanied by hieroglyphic inscriptions revealing the name, condition, and date of decease. A study of those works led to the conclusion that three distinct types were indicated. (1) The primal Egyptian, bearing no trace of negro or Arab, but more nearly matched by a high European fácies of the present day. (2) The type of the conquering race of Shepherd Kings, or Syro-Arabian, exemplified in the Assyrian sculptures. (3) The Nubian Egyptian, typified in the bas-relief figure of Cleopatra in the Temple of Denderah. In conclusion, the professor drew a graphic picture of the high state of civilization attained by the Primal Egyptian race, whose exquisite works, done six thousand years ago, are now rendered accessible to man. The paper was amply illustrated by a series of photographs, maps and diagrams.—*Nature.*

MICROSCOPY.

Improvements in Insect Mounting.—The lesson of the fly in amber was one which took us a long time to learn, or rather which we never learned well until, now, its whole secret comes to us from India. Mr. Staniforth Green, of Ceylon, has sent a collection of mounted insects to London, which have been presented to the Queckett club by Mr. Curties. They are represented by Messrs. Curties, Ingpen, Loy, McIntire and others as well preserved and satisfactory objects, free from cloudiness, air bubbles, or deterioration of tissue as well as from distortion of form. Not being flattened or eviscerated, they show to great advantage in the binocular microscope. A few had been soaked in potash solution, but these were the least satisfactory members of the collection. The largest and best part of the objects had been immersed in the medium without maceration or other preparation. The smaller insects were simply killed by immersion in ether and immediately transferred to the soft balsam; the larger insects were similarly killed in ether, then dried a few days under slight pressure between the leaves of a book, and afterward soaked in turpentine and transferred from that to balsam. The balsam containing the insects was kept in the tropical sun for some time, until all moisture was dissipated and the balsam had pervaded the whole of the tissues. The muscles and other internal and external organs, not having been disorganized by potash or in any other way, were well preserved and capable of inspection; and in many cases polarized well. Small delicate insects which are difficult of preservation or even of study in any other way, are most successful in this; as, for instance, aphides, small and frail diptera, hymenoptera, minute spiders, eggs, larva, pupa, etc. This method is of value not only to the microscopist, but also to the entomologist, placing rare or frail specimens out of reach of dust, mould, ants, and other dangers which threaten dried specimens.

We have tried this method largely, both with thin balsam, and with hard balsam dissolved in chloroform and in benzol, and have succeeded with all. Probably experience will show that each is best adapted to certain objects. A water-bath is a good substitute for the tropical sun. When the balsam is sufficiently hard the objects should be mounted in it in glass cells. Doubtless the sand-blast cells will prove to be adapted to this purpose.

MEASURING ANGULAR APERTURE. — Mr. Wenham, in order to gain accuracy in measuring the angular aperture of dry objectives, would like to cut off all stray light that might enter the lens without being capable of forming an image, by placing over the objective a conical nozzle having a small aperture in its apex. This aperture would correspond to the focus of the lens, and the nozzle would just include the cone of rays capable of forming an image and would exclude all false rays of any considerable angle. This method would be inconvenient, however, and as the angle is measured by a horizontal movement a vertical slit will be a satisfactory substitute. For high powers the slit must have thin edges; and it must be capable of adjustment to the width of focus of the lens. His arrangement is easily made and used. A plate three inches long and one inch wide has a central aperture nearly one-half inch wide, the edges of this opening being bevelled away below so as to admit a large angle of light. Upon this plate lies a glass slip about 2 in.×½ in., pressed against at one end by a spring, and at the other end by a screw, so that it can be easily slid backwards and forwards under the two staples (one inch apart) which hold it upon the surface of the plate. The slip is formed by the edges of two slips of platinum foil (·001 thick) one of which is cemented with Canada balsam upon the glass slip, while the other is fastened under one of the staples so as to lie on the glass slip but not move with it. These platinum slips never overlap; but their edges may be brought in contact, or may be separated as widely as desired by means of the set-screw pressing against one end of the glass slip which carries one of them. In measuring angles the usual method of rotating the instrument horizontally is employed; only this apparatus lies upon the stage with its slit in focus of the objective and adjusted in width so as barely to include the whole breadth of the focus. If the stage of the microscope is too thick to admit full angle of light, the apparatus may be arranged below the stage and the objective focussed down to it.

CATALOGUING MICROSCOPIC SPECIMENS. —At the Medical Microscopical Society, a paper by Mr. Groves was read on the subject of cataloguing and arranging microscopic specimens. Though classification was deemed necessary in large cabinets, yet it was considered entirely undesirable in small ones, and in both cases the catalogue and not the arrangement was relied upon for finding objects. The method of cataloguing recommended consists of an ordinary alphabeted note book in which, under the proper alphabetical heading, every portion of each specimen is independently entered and the slide referred to by numbers or otherwise. Thus one excellent slide which shows well a number of points of structure will be entered under several headings and be used to illustrate all these points, while under the usual methods of classifying slides in series, a number of duplicate slides would be required to fill up the different series. All difficulty in finding specimens is also positively obviated.

The president, Mr. Jabez Hogg, expressed the belief that the proposed plan would supersede all others now in use.

SAND-BLAST CELLS. — Mr. Henry F. Hailes contributed to the Queckett Club an account of a new and probably valuable application of the sand-blast process. It had occurred to him that this process might be employed to sink cells in glass slips for microscopical mounting; and he applied to the inventor, Gen. Tilghman, who had a supply sunk in an apparently satisfactory manner. Mr. C. Baker, the optician of High Holborn, has undertaken to supply these new cells to the trade. They can be sunk of any desired size and shape, and possess the positive advantage of having no joint at the bottom of the cell. Of course the floor and sides of the cell are rough or "ground" surfaces, but this is not a serious disadvantage. For opaque objects the ground surface forms an agreeable background; for objects in balsam, the refractive index of the medium corresponds so nearly with that of glass that the granulations of the glass surface are optically obliterated and disappear entirely; for media of less refractive power than balsam, it is necessary to varnish first the ground surface with balsam and allow it to dry before introducing the fluid. The new cells seem particularly available for foraminifera, insects mounted without flattening, and other clumsy specimens, whether in air or balsam or glycerine.

ANOTHER MICROSCOPICAL CEMENT. — Mr. T. Charters White recommended to the Queckett Club four or five parts of common yellow beeswax melted with one part of Canada balsam for this purpose. Like the electrical cement, and the paraffine, which have already come into general use for the same purpose, it is applied melted, on a hot wire, after the manner of soldering; sets as soon as cool, and hence cannot run in under the cover however thin the cell may be, and can be instantly loosened by warming if the cell is to be repaired or the object dismounted for any purpose. It is especially applicable to dry mounting, to temporarily fixing objects for early use, and to fasten apparatus where contrivances, as growing cells, etc., are extemporized for immediate use and without care as to their durability.

NEW APPLICATION OF STAINING TO PATHOLOGY.—Dr. H. C. Major claims that healthy and morbid tissues are affected by logwood staining-fluid—with such different degrees of facility as to afford a really valuable means of discrimination. Thus staining becomes a means of diagnosis as well as of defining the structure of cells, etc. He instances sections of brain in cases of acute mania and of senile atrophy, in the former the gray cortical layer and in the latter the internal white substance being most deeply stained and best defined.

NOTES.

THE governor of Minnesota calls on the general government for aid. as owing to the ravages of the grasshoppers for two years past "many thousands are now (July 8) suffering for food." An "utter and wide-spread destitution exists in the southwestern counties of this state among the new settlers, whose crops have been destroyed for two years." He asks for contributions of money and provisions to relieve the immediate necessities of the sufferers. Why should not the grasshopper be eaten in turn? The grasshopper or locust of the east is universally eaten in portions of Africa and western Asia, and pronounced a nutritious and palatable article of diet by Arab chiefs as well as Hottentot savages. They are eaten roasted whole, minus the legs, or roasted and powdered. We wonld recommend that experiments be made as to the best mode of preparing the locust for food. They should be thoroughly cooked to guard against parasitic worms. Not willing to urge the use of grasshoppers as food for others without first eating them ourselves, we may say that we have found the grasshopper, first killed by boiling water, and then fried in butter, at least as palatable as many articles of food eaten by civilized people; and to people actually famishing, as is said to be the case in Minnesota, it will be worth their while to avail themselves of a food stuff which millions perhaps of people of other lands regard as wholesome.

THE Proceedings of the 22d, or Portland meeting of the American Association make a much more bulky volume than any of its predecessors. It is noticeable that while the papers in the section of Mathematics, Physics and Chemistry, occupy perhaps no more space than usual, those in Natural History fill 409 pages. The papers are perhaps up to the average, but we notice two or three that might have been weeded out by the publishing committee. The volume appears with a commendable degree of promptness.

Mr. G. R. CROTCH of England, known for his studies on the Coleoptera, died the last of June at Philadelphia, of consumption. He was the author of several valuable papers on Coleoptera and an indefatigable collector. He lately spent a year in California and Vancouver Island and adjacent regions, making extensive collections, mostly contained in the Museum of Comparative Zoology.

BOOKS RECEIVED.

Observations on the genus Unio; with Descriptions of New Species, and Descriptions of Embryonic forms and soft Parts. Also New species of Strepomatidæ and Limnæidæ. By Isaac Lea. Philadelphia, 1874. 22 plates. pp. 74. 4to.

Proceedings of the Academy of Natural Sciences of Philadelphia. Part I. Jan.-March, 1874, plates. pp. 72. 8vo.

Bulletin Mensuel de la Societe d'Acclimatation. Paris. Fevrier, 1874. 8vo. pp. 97-160.

Seventh Annual Report of the Provost to the Trustees of the Peabody Institute of the City of Baltimore, 1874: 8vo. pp. 45.

The Second Annual Report of the Board of Managers of the Zoological Society of Philadelphia 1874. With plates. 8vo. pp. 32.

Transmission of Disease. First Paper, Consumption. By A. C. Hamlin, of Bangor, 1874. pp. 9. 8vo.

Transfusion. By A. C. Hamlin, of Bangor, 1874. pp. 14. 8vo.

Annotated List of Birds of Utah. By H. W. Henshaw, Salem, 1874.

Proceedings of the Royal Society of Edinburgh. For 1872-73. Vol. viii, No. 85. pp. 206. 8vo.

The Principles of Science. By W. Stanley Jevons. MacMillan and Co., New York, 1874. With plate. pp. 487. 8vo. Price 5.00.

Proceedings of the Boston Society of Natural History. 1874, Vol. xvi. Part iii. pp. [illegible]. 8vo.

Notes on the Mammals of Portions of Kansas, Colorado, Wyoming and Utah. By J. A. Allen. Salem, 1874. pp. 43-66. 8vo.

Metamorphism Produced by the Burning of Lignite Beds in Dakota and Montana. By J. A. Allen. Boston, 1874. pp. 19. 8vo.

Geographical Variation in Color among North American Squirrels. By J. A. Allen. Boston, 1874. pp. 21. 8vo.

Geographical Variation in North American Birds. By J. A. Allen. Boston, 1872. pp. 19. 8vo.

Papers, Chiefly Anatomical. Presented at the Portland Meeting of the American Association for the Advancement of Science, August, 1873. By Burt G. Wilder. Salem, 1874. pp. 211-[illegible]. 8vo. With plates.

Bulletin of the Buffalo Society of Natural Sciences. Warren, Johnson and Co., Printers. Vol. ii. No. 1, 1874. pp. 104. 8vo. With a plate.

Monthly Report of the Department of Agriculture for June, 1874. Washington pp. 243-255. 8vo.

Verhandlungen der kaiserlich-koniglichen Zoologisch-botanischen Gesellschaft in Wien. Band xxiii. Wien, 1874. pp. 740. 8vo. With plate and photograph.

Abhandlungen herausgegeben vom naturwissenschaftlichen Vereine zu Bremen. Band iii. (Schluss) Heft iv. Band 4, Heft 1. C. Ed. Muller, Bremen. 1873-1874. 8vo.

Tabellen uber den Flacheninhalt des Bremischen Staats, den Waesserstand der Weser und die Witterungsverhaltnisse des Jahres 1872. Beilage No. 3, zu den Abhandlungen des naturwissenschaftlichen Verein zu Bremen. C. Ed. Muller, Bremen, 1873. 4to.

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe. Band lxvii, Abtheil ii, Heft iv and v, Abtheil iii, Heft i to v. lxviii Band i, Abtheil i and ii, Heft ii, Abtheil i and ii, Heft. Wien, 1873. 8vo. With plates.

Zeitschrift fur die gesammten Naturwissenschaften. By C. G. Giebel. Berlin, 1873. Neue Folge, Band vii with plates, pp. 522 and Band viii. pp. 582. 8vo.

Sitzungs berichte der Gesellschaft Naturforschender Freunde zu Berlin. Berlin, 1873, pp. 112. 8vo.

Bulletin Mensuel de la Societe d'Acclimatation. 3me Serie. Tome 1, No. 3. Paris, 1874. pp. 161-256. 8vo.

Berliner Entomologische Zeitschrift. Jahrg. xvii (1873), 3-4. With plate. Jahrg. xviii (1874), 1-2. pp. 243-450, 9-240. 8vo.

On the Homologies and Origin of the Types of Molar Teeth of Mammalia Educabilia. By Edward D. Cope. Philadelphia, 1874. pp. 23. 8vo. With a plate.

Report on the Fossil Plants of the lower Carboniferous and Millstone Grit Formations of Canada. By J. W. Dawson. Montreal, 1873. pp. 47. 8vo. With plates.

THE

AMERICAN NATURALIST.

Vol. VIII.—SEPTEMBER, 1874.—No. 9.

THE AGRICULTURAL ANT.*

BY DR. G. LINCECUM.

SINCE my return from Mexico, I have discovered several traits in the character of the *Myrmica molefaciens* that I had not noticed before. In fact, the circumstances that have developed the facts I am about to notice had not transpired.

In 1848, the year I came to Long Point, there was but one agricultural ant city within a mile of the place. This nest was situated in a nearly barren little spot on top of an elevation, underlaid with stratified sandstone. Here there was but little grass and weeds to interfere with their seed collecting labors. The ant rice which they so carefully cultivate was flourishing in a regular circle near the outer border, but inside of the pavement. There were little patches of the same grass scattered about on the little glade which had doubtless been planted there by some experienced ant, for it had been neatly cleared of all other vegetables, in fact cultivated by them.

The entire surrounding country consists of very rich black prairie soil, and was bearing a very heavy coat of cowfodder grasses. In this dense coat of grass the mound builder could not travel; but was content to confine himself to a single city in the open district, until a road that passed near the pavement had been tramped out through the deep grass. This occurred about two

---

*Communicated to the Smithsonian Institution, and published by the permission of Professor Henry.

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

years after my first acquaintance with the above named city. It was interesting to observe how soon they availed themselves of the use of the clean hard-trodden road. They were seen running along in trains half a mile from their city, and it was not long before new cities were seen along the side of the road. The first one made its appearance about eighty yards from the old city and just far enough from the road to be out of the way of the passing teams.

These new cities, which, in the course of three years, made their appearance at intervals of about eighty yards along the side of the road for more than a mile, were never seen before; they were a year and a half old. One of their peculiarities is, that with bits of stick, little balls of soil and the like, they conceal the entrance of a new city until they consider themselves sufficiently strong to make their appearance and sustain themselves among the nests of other ants. They are then seen clearing out and paving a considerable circular space around the entrance to their city. Some old settlements have a pavement fifteen feet in diameter and a mound in the centre a foot high.

And now the increasing cattle made the grass thinner, and the ants swarming out spread their cities in all directions at short intervals (thirty yards is about the average) until the prairies are full of them.

They do not, like the bees, throw off colonies, to go out and build up a new kingdom. It is a very different process. On a certain day in summer all the males and females—they all fly—assemble, as if by appointment, from all the surrounding nests, at some suitable place; generally in the smooth road, where they seize each other, three or four males to one female and wallowing on the ground eagerly, give the idea of a battle; which the careless observer is sure to report as such. It is, however, no battle, but a rampant amative furor, which continues three or four hours, when the female becoming satisfied with her numerous, eager lovers, makes shift to tear herself loose from them and make her escape. At first she climbs up some little weed or spear of grass, and seems to rest for a few minutes, when she spreads her glassy wings for the last time, and flies with the wind until she is tired, or till some counter current casts her to the ground. She seems now in great haste, and running around, she soon selects a place, where she energetically goes to work digging a small hole, which, when she has deepened sufficiently for her wings to prevent her free ingress, she deliberately withdraws and with her sharp mandibles clips them off. She now continues her labors until the hole is six or seven inches deep, and excavating a small cell at the bottom, she closes the passage above, and remains sleeping in her little cell nine or ten days. If she survives that long, she comes out, procures some food and goes to work, deposits twenty or thirty eggs, raises them to maturity;—they are all workers—and after this the queen or mother ant is seen outside no more. She conceals the entrance to her kingdom, keeps her workers busy, increases their number rapidly, and in the course of eighteen months, finding her armies sufficiently strong, she throws off all disguise and clearing a considerable space around the gate of the city commences to pave it and to build up a monument or pyramid. This last is a public work as well as the pavement, and it is carried on slowly by the police, who are always found on and around the environs of the city.

Thus have I partially described the origin and progress of a single successful mother ant of the mound building species. Were all that fly away from those astonishing connubial assemblies equally successful, it would require but very few years for them to overpeople the whole earth. But nature, as she has done in all other races of animal life, has made provisions for the destruction of the superfluous queens. Great numbers of them never return from the little cell they have prepared for themselves at the bottom of their new home. They die either from having packed the dirt in the hole above them, or from being found by the hunters or soldiers of the surrounding kingdoms, whose custom it is, whenever they discover one of these new beginnings for a city, invariably to dig out and assassinate the occupant. Many birds are fond of the females of this species of ant, devouring all they can find. There are many other causes for the failure of these fat queens which, according to my observations on the subject, result in the conclusion, that not exceeding one in a thousand of those beginning a nest survives and builds up a colony.

I have witnessed several of their grand connubial festivals. One I saw in 1858, that occupied a plat of ground 107 yards in length and ten yards wide. The ground was thickly strewn with them. When I first discovered them they were coming from every direction, and lighting down on the above described plat by tens of thousands. It was a great day with the ants; and soon the place was so completely carpeted with them that it was impossible to walk among them and not crush them.

In the course of three hours the males began to show the dreadful effects of their dissolute course. They began rapidly to die. The females would wring themselves loose from the males and fly off, leaving them exhausted and struggling in death. They had fulfilled their mission, and the ground long before night was covered with their dead bodies.

I visited the place the next morning; the wind had driven them into the little gullies in the road, and there could not have been less than a bushel of them. Not a female dead or alive to be seen anywhere amongst them. But not far off, and in the direction the wind was blowing at the time they made their escape from their prostrate and dying lovers, could be seen countless numbers of little black piles of earth which had been thrown out of their holes during the night. There were fifteen to twenty of these new burrows to every square rod, and they were seen in that proportion for more than a mile. So it is plain, if there were no counteracting influences, to see that they would soon occupy every available space. Few of them, however, proved successful, for the whole prairie had already been fully stocked with them. Pavements were to be seen every thirty or forty yards, but too new to possess any mounds. Their pavements were flat when in 1868 I went away; and now I have got back in 1873 I find they have made great improvements; all have raised mounds, some of them quite large. The progress they have made on their mounds and pavements is very conspicuous.

This species of ant subsists almost entirely on small seeds, great quantities of which they store away in their granary-cells to supply food for winter. During rainy seasons in the autumnal months it happens right often that the ground becoming saturated, the water penetrates their granaries, and swells and sprouts their seeds. In this emergency they bring out the damaged grain the first fair day, and exposing it to the sun until near night, they take in all that is not actually sprouted. I saw them in G. W. Gentrey's farm one day have out on a flat rock as much as a gallon of wheat sunning. I wanted to see how they would manage to get so much back again, and returned again that evening just in time to see their hosts come out and carry it in in five minutes.

There are many other interesting achievements performed by this sagacious race of insects. I have recently discovered a great difference in their mental operations and capacities. Individuals there are which possess great intellectual superiority to the common laboring classes, which is manifested in the fact that they assume the leadership in all their important public works and army movements. Some are much more sagacious and cautious in avoiding traps and dangerous contrivances set for them by the scarcely superior human genus.

One of our Germans invented a very destructive ant trap. It is set over the entrance to their city, and is so contrived, that going or coming it is sure to entrap them; but not all of them. Occasionally a well formed fellow is observed to arrive at the top of the precipice, where he stops and gravely and cautiously surveys the awful abyss below, filled with frantic and terribly distressed thousands—who have incautiously precipitated themselves into inevitable ruin—and after viewing the dreadful and disastrous condition of his fellow laborers, he seems to understand the true nature of the misfortune, and turning from the irremediable calamity, hastens down the inclined place into the grass weeds, beyond the reach of further observation.

Quite a number of them are seen to examine and hastily fly from the entrance of this destructive trap.

AZALEA VISCOSA, A FLY-CATCHER.

BY W. W. BAILEY.

THE many curious observations published of late in regard to vegetable fly-catchers have opened my eyes to such phenomena as are presented in my forest walks. As is well known to all botanists, our sweet swamp azalea (*Azalea viscosa*) has its corolla covered on the outside with innumerable clammy and glandular hairs. Each hair is a prolongation of the cuticle and is surmounted by a purple and globular gland. In the bud, these hairs appear to cover the whole surface of the flower, but when the corolla expands, they are seen to occupy the midrib of the petals as well as the tube of the corolla. These glandular hairs are efficacious fly-catchers, but what the object is in thus securing insect prey, I will not pretend to state.

I have been amusing myself, if any such apparently cruel occupation can be considered entertaining, in watching the capture of flies by the azaleas. When I first brought the flowers home, many small insects, as winged ants, were entrapped amidst the hairs. These have remained alive several days, still vainly struggling for freedom. As the houseflies are abundant in my room, it occurred to me that I might extirpate the pests, and at the same time learn something of the process of insect-catching. I have not noticed that the powerful fragrance of the blossoms attracts the housefly, although I have no doubt that it does the smaller insects. It seemed to be accidental when the houseflies were captured. I exposed a number of buds and fully opened blossoms on a sunny window-sill thronged with flies. It was not many minutes before I had several captures. A mere touch of a fly's leg to the glutinous hairs was sufficient for his detention. A struggle only made matters worse, as other legs were by this means brought in contact with the glands. These emit long glairy threads which fasten to the hairs of the flies' legs. They may be drawn out to a great length and tenuity, still retaining their strength. If two buds are pressed together and then drawn apart, innumerable threads may be seen to bind them. There is a complete network of them between the various glands. They will confine the strongest fly; he is at once held like Gulliver among the Liliputians. Under the microscope, the legs of the fly are seen to be covered with the secretion, which is perfectly white and transparent. In one attempt to escape, a housefly lifted a flower bodily from the window-sill, perhaps a quarter of an inch, but at once sank back exhausted amidst the hairs. One, after long efforts, escaped, but seemed incapable of using its legs; it flew away readily. In one instance, I have found the dried remains of a small insect embedded amidst the hairs, but cannot say whether its juices were in any way absorbed by the plant. If such assimilation takes place, what is its purpose? Can this phenomenon of fly-catching be in any case accidental, or is some nice purpose concealed in it? I merely state the facts as I have observed them; perhaps others can supply further information.

ON THE ANTENNÆ IN THE LEPIDOPTERA.

BY AUG. R. GROTE, A. M.

IN a paper read before the Portland meeting of the American Association for the Advancement of Science, I endeavored to show that the antennæ in the moths, or night-flying Lepidoptera, were more highly specialized than in the butterflies, and that this specialization of structure was correlated with habit in these insects. I stated that the antennæ were more actively used by the moth than by the butterfly, and I suggested that their sensitiveness was a protection and an assistance to the night-flying moths in directions where a change to a diurnal habit rendered such sensitiveness less necessary to the butterfly. In two instances I was led to reject conclusions with regard to the antennæ that had already appeared in print. The first of these is the hitherto accepted and arbitrary division of the Lepidoptera into two sections under the terms Rhopalocera, or club-horned, and Heterocera or diversely-horned. I endeavored to show, that the change in the antennal form was a gradual one, from the neuropteriform antennæ of the Tineidæ, or lowest moths, to the butterfly-like antennæ of the Castniares, or highest moths; that the antennæ of the Hesperidæ were quite different from the butterflies; and that the change in antennal structure throughout the suborder was really expressed by a greater rigidity and equalization in length, or was one of direction and attitude. As the antennæ become less serviceable to the insect they become more rigid and in position more elevated above the head, as in the butterfly, while in the moth they are more whip-like and are directed forwards or, in a state of rest, frequently thrown backwards by the sides of the body, beneath the wings. The second instance is that of Dr. Clemens,* who came to the conclusion that the antennæ, in the Lepidoptera, "instead of being organs of any special sense, as they are usually regarded, are instruments of atmospheric palpation." I have endeavored to show that Dr. Clemens' experiments with the moth *Platysamia cecropia*, instead of being confirmatory of this view, point to an exactly opposite conclusion. Neither by smell nor hearing could the night-flying moth, deprived of its antennæ, become sensible of direction or locality, and under its condition of mutilation it naturally refused to proceed. A very strong argument would indeed be needed to confirm the fact that in a single suborder of insects, so important and widely developed an organ as the antenna was devoted to an exceptional use, while the absence of any structural connection between the wings and the antennæ renders such a construction impossible. It appears rather that the senses of smell and hearing are not differentiated in insects and that the antennæ are organs of perception receiving impressions from either sense. The "assembling" of the Bombyces has its cause probably in the greater specialization of the male antennæ, which are sensitive to the odor of the female as well as to the waves of sound. It is not extraordinary to find such a means for the preservation of the species highly developed in a group where the maxillæ are feebly developed, little or no food is taken, and the duration of life in the reproductional stage is so brief as in the Bombyces. Having watched the free habit of the butterflies, I have thought that these depended more on the organs of vision for a recognition of the sexes, and I have detected instances of necessarily harmless coquetry between the males of Argynnis; an action not unrelated to that observable among dogs and higher animals. Professor Mayer's experiments with the male mosquito, as narrated in the AMERICAN NATURALIST, vol. 8, p. 236, are confirmatory of these views, as showing the sensitiveness of the antennæ to the waves of sound, and it is not unreasonable to suppose that the antennæ of the male insect are particularly sensitive to the peculiar sounds and odors emitted by the female of its own species.

---

* Journal Acad. Nat. Sci. Phil., 1859, p. 122.

In the absence as yet of conclusive evidence as to cases of peculiar sensitiveness to odor or sound, it may be sufficient to feel sure from what has been adduced of the general functions of the antennæ, and it has been the object of the writer to show that the point of view from which systematists have hitherto regarded the antennæ is unfertile, and to direct attention to the real differences in antennal structure between the butterflies and moths, while showing that the antennæ are modified by desuetude in the former and higher group.

THE SOCIAL LIFE OF THE LOWER ANIMALS.*

BY PROF. P. J. VAN BENEDEN.

In that great spectacle which we call nature, each animal plays a distinct rôle, and He who weighs and rules all with order cares as much for the preservation of the most repulsive insect as the propagation of the most brilliant bird.

In coming into the world each of them knows its place, and fills it the better as it is more free to obey its instinct. Each carries his prompter about with him, and man may be compared to their manager.

Over this great drama of life presides a law as harmonious as that which rules the movements of the stars; and if at each hour, death carries off from this scene myriads of beings, at each hour also life causes new legions to replace them. It is a whirlwind, a chain without end.

It is demonstrated to-day, that the animal, whatever it may be, whether that which occupies the top of the scale, or that which touches the last confines of the kingdom, consumes water and carbon. Albumen suffices for all the wants of life. The same hand, however, which has brought the world out of chaos, has varied the nature of this consummation; it has proportioned this universal nourishment to the needs and to the particular organization of the species which should draw from it the principle of motion, the maintenance of life.

It is a very interesting study, that which has for its end a knowledge of the food of each species. This study constitutes an important branch of the history of animals; the bill of fare is written in advance in indelible characters in each specific type, and these characters are scarcely less difficult to decipher for the naturalist than the palimpsest or the archæologist. It is under the form of a bone or of scales, of feathers or of shells, that these culinary letters figure in the digestive tracts. It is by visits not domiciliary but stomachal, that we are to be initiated into these details of household economy.

---

* Translated from La Revue Scientifique.

The bill of fare of fossil animals, though written in characters less clear and less complete, can, however, still often be read in their coprolites. We should not despair even of discovering some day the fishes and the crustacea which were devoured by the plesiosaurs and the ichthyosaurs, and of finding that some parasitic worms may have been introduced with them into their spiral cæcum.

Naturalists have not always studied with sufficient care the relations which exist between the animal and its food, though these relations would furnish the observer with information of a high importance.

Every organic body, conferva or moss, insect or mammal, becomes the prey of some beast; liquid or solid, sap or blood, horn or feather, flesh or bone, all disappear under the teeth of one or the other; and to the remains found in each correspond the instruments necessary for their assimilation. These primitive relations between animals and their diet maintain the industry of each species.

We find on taking a nearer view, more analogy between the animal world and human society, and, without seeking farther, we can say there is no social position which has not its counterpart among the animals.

The greater number of them live quietly on the fruits of their labor, and practise a trade which supports them; but aside from these honest industries, we see also certain miserable beings which cannot live without the aid of their relatives, and establish themselves, some as *parasites* in the thickness of their organs, the others as *commensals* by the side of their host.

It is some years since one of our learned and intelligent confrères of the University of Utrecht, Professor Harting, wrote a charming little book on the industry of animals. He has drawn our attention to the fact that most of the trades are perfectly known in the animal kingdom. We find indeed among them miners, masons, carpenters, paper-makers, weavers, and we may even say lace-makers, who work at first for themselves, and afterwards for their offspring. Then there are some which dig the soil, strengthen arches, clear up useless pieces of land, and like miners consolidate works;[*] others build huts or palaces according to all the rules of architecture;[*] still others know how to steal all the secrets of the makers of paper, of pasteboard,[†] of cloth or lace,[‡] and their products have generally nothing to fear in comparison with the point lace of Malines or Brussels. Who has not admired the ingenious and cunning construction of the nests of bees and of ants, the delicate and marvellous structure of the webs of the spider?

---

[*] The Mygales among spiders, the Andrena, the mole-cricket, the ant-lion, the Arenicolæ, Terebrellæ, Sabellæ, Tubifex, etc., among the worms. There are also some

The perfection of the tissues of some of these fabrics is even so highly appreciated that when, for his telescope, the astronomer wants a fine and delicate thread, it is not to Paris or London he sends, but to a living manufacturer, to a lowly spider! When the naturalist needs to compare the degree of perfection of his microscope, or of a micrometric measure for infinitely small beings, he consults, what? a millimetre cut and divided into a hundred or a thousand parts? No! simply a shell of a diatom,[§] so small and indistinct that it has to be magnified several million times in order to be visible to the naked eye, and the best microscopes do not yet always reveal all the delicacy of designs which adorn these wonderful organisms; it is with difficulty that the instruments of the first masters suffice to observe the infinitesimal fantasies which decorate these liliputian shells.

Finally to whom do the manufacturers of Verviers or of Lyons, of Gand or of Manchester go for their first designs? To an animal, a flower; and even to the present day we have been unwilling to imitate their example. These workshops are in operation every day under our eyes, their gates are largely open to all the world,

---

Mollusca, as the Pholades and Teredo, which make a submarine domicile in wood, whether stationary, or floating about. There are in like manner several mammals; the Chinchilla of Peru, the Bathyergus and the Orycteropus of the Cape of Good Hope, the marmot, the Sphermophilus and the badger, as also the small mammal known to every one, the mole.

There are also those which construct small boats which the waves never submerge; we have in fresh water the sticklebacks; and in his last voyage, L. Agassiz has drawn attention to a fish which constructs its nest in the sargasso weed. The most important discovery, says the illustrious naturalist of Cambridge, has been that of a nest built by a fish, and floating on the broad ocean, with its freight living in the middle of the sea.

[*] The bees and white ants, which build houses thirty feet high, wasps, etc.

[†] Different species of wasps, especially *Chartergus chartarius* of South America, *Polistes tepida*, *Vespa vulgaris* and *sylvestris*.

[‡] Several spiders, *Epeira diadema*, *Argyronecta aquatica* and especially *Tinea sequella*, the cocoon of which was the admiration of Lyonnet. The Argyronecta constructs even a diving bell. Among the sponges, *Euplectella aspergillum*, Hyalonema and Holtenia likewise construct palaces of lace.

[§] *Pleurosigma angulatum*; *Amphipleura pellucida*, etc., etc.

and none of them are marked with the hackneyed inscription — *No Admittance.*

Should these machines stop, or should they only rest for a time, we should be exposed to the chances of not being able to cover the nakedness of our shoulders; the fine lady would have no more cashmere, nor silk nor velvet; as for us, we should have no more flannels, nor cloths to cover us; the shepherd even, as also the mountaineer, would no longer have his goatskin to protect himself against the inclemency of the weather. It is by the kindness of this good creature which gives us its flesh and fleece, that we can leave the south to brave the rigor of the northern climates and establish ourselves by the side of the reindeer and narwhal among perpetual glaciers.*

We have science and steam, of which we are justly proud, but in order to manufacture their marvellous textures, the animals have only their simple instinct, and yet make them much better than we. How instructive is this parallel between the products of nature and those of man! How it lowers our pretensions!

The pretended blind forces of nature produce offspring that the genius of man may seek in vain to replace, and we would not dream of contending with these living machines which we every day crush under foot.

The greatest industry would be invariably surpassed did we place in one of our great universal expositions its products side by side with those of the insect or spider. In order to conform to the ideas of equality of this age, we should not in taking sides forget our pretended ancestors.

There are all sorts of pursuits in this world, and if some of them are honest, we can say that there are others which scarcely deserve this qualification. In the old as in the new world more than one animal is a swindler, leading the life of a fine gentleman,† and it is not rare to find by the side of the modest pickpocket,‡ the audacious brigand of the highway§ who lives by blood and carnage. The number is even as great as those rowdies of the far West who always escape, whether by some ruse, or by audacity, or by a superiority of wickedness, social punishment.

---

* The mouflon (*Ovis musimon*) and the bouquetan (*Capra ibex*) which have become our sheep and our goats.

† The Paguri, or Bernard the hermit (*Eupagurus bernhardus*), Cenobites and several others.

‡ The beef-eater, the starling, the kite.

§ The sharks generally.

But among these independent existences there are a certain number, who, without being parasites, cannot live without aid, and who claim from their relations, sometimes a simple resting place at the same table to divide the meal of the day; we daily discover some which pass as parasites, but which, however, do not live in any other way at the expense of their host.

Although a copepod crustacean is installed in the body of an Ascidian, and intercepts the passage to its mouth of some good tidbits, yet we cannot regard it as a parasite.

But should an animal kindly render a service to his neighbor, whether keeping his set of teeth in order,[*] or in removing the detritus which encumbers certain organs,[†] we cannot say that it is a parasite. It is no more a parasite than he who squats by the side of a vigilant and clever neighbor and quietly takes his siesta,[‡] or he who contents himself with the fragments which fall from the jaws of his acolyte.[§] It is no more a parasite than he who, like the Remora, lazily anchors himself to a good swimmer, and fishes by his side without fatigue to his fins. All these animals are no more parasites than the traveller who installs himself in a pleasure carriage, extends his hand in passing, or carries a crust of bread in his pockets. There are also mutual services rendered among several species, services performed by reciprocal kindness, and *mutualism* can even take its place by the side of *commensalism*. Those which deserve the name of parasites are maintained at the expense of their neighbor, whether they reside voluntarily in its organs, or abandon it for a while after each repast, as the leech or flea.

The true parasites are very numerous in nature, and we should wrongly imagine that they live an unhappy and monotonous life. There are among them some alert and vigilant enough to sustain themselves for a part of their life, and only need aid at determinate periods. They are not, as has been believed, exceptional and strange beings without any other organs than those simply for maintaining life. A large number of them are as well provided as others with organs for working, and only seek aid at certain periods in their lives. There is not, as has been thought, a special class of parasites, but all classes of lower animals contain them. We may divide them into different categories; in the first we may reunite all those which are free at the beginning of life, swimming about and taking their sport without seeking aid of any one, until the infirmities of age oblige them to seek refuge. Covered with the *toga pretexta* they live at first like true Bohemians and take their rest in some good inn.[*] Sometimes it is both the males and females which seek this kind of aid at the coming on of old age;[†] at other times it is the females alone, while the male continues his vagabond life.[‡] It happens also that the female drags along her spouse, and maintains him completely during his captivity; the male remains a small boy in size as well as habits, and if the host who feeds her, serves him with liquor, she in her turn affords her husband food.[§] Few females of the Lernæans can be found which do not carry about with them their liliputian males, who do not quit their wives any more than their own shadows. All the parasitic crustacea take their place in this first category.

---

[*] A plover enters the mouth of the crocodile and removes the débris that the animal, from its immobile tongue, cannot get rid of. It is a living toothpick. This fact was already known to Aristotle and has been since verified.

[†] The opalinas of the rectum of frogs.

[‡] A screech owl in Mexico places itself under the care of a small subterranean rodent, excessively alert and vigilant, the spermophile. He acts as sentinel at the door of this house, say the people of the country, and the owl lives in perfect quietude.

[§] An annelid of the genus Nereis establishes itself by the side of and in the same shell with the hermit crab.

We also find some—those hobgoblins of ichneumons for example—which are perfectly free in their adult age, but call for support in their youth. There are numbers of these insects, which on leaving the egg are literally put to nurse; but the day when they throw off their larval robes, they know no restraint, and armed from head to foot, they bravely seek adventures like other insects.[‖] In this category are found the parasitic dipterous and hymenopterous insects.

There are also some which are classified from their mode of life; all changing their hotel, not to say establishment, according to their age and constitution. From the time they leave the egg they solicit favors, and all their journey is vigorously marked out in advance. We happily know to-day the steps in this journey of the cestode and trematode worms. These flat and soft worms begin life in a sort of vagabondage, provided with a ciliated coat, which serves them as a locomotive garment, but scarcely do they essay to use their delicate limbs, than they claim the aid and lodge in their first hotel; restless and unquiet, they soon abandon it for another home, and then reëstablishing themselves are condemned to perpetual seclusion.

---

[*] All the Lernæans, the ticks, etc.

[†] The Bopyridæ among crustacea.

[‡] The *Filaria medinensis*, or guinea worm, and several others.

[§] The Lernæans in general.

[‖] The Ichneumons and Œstrus among insects.

That which adds to the interest which these feeble and timid beings inspire, is that at each change of their domicile, they change their costume, and also, arrived at the end of their peregrinations, they wear a virile toga, not to say a wedding dress. It is only under this last envelope that the sexes appear, for up to this time they have thought little of family cares.

Most of the worms which have the form of a leaf or of a ribbon, are subject to these peregrinations accompanied with changes of costume, and those which do not arrive at their final stage, generally die without posterity.

Not the least interesting is the fact that these parasites do not inhabit indifferently such or such organs of their host; all begin modestly by the almost inaccessible mansard roof, and end their lives in the large and spacious apartments of the first floor. At first they care only for themselves, and are contented, under the name of *Scolex* or vesicular worms, with connective tissue, muscles, the heart, the ventricles of the brain, or even the ball of the eye;* later they busy themselves with the cares of their families, and occupy the larger organs, as the alimentary and respiratory tracts, always in free communication with the outer world; they have a horror of being shut up, and their offspring reclaim an existence in the broad world.†

It is not always easy to indicate the identity of those personages which visit one day the saloons, in embroidered dress, the next the most obscure closets in a beggar's costume.

There is a last category in which are found those who claim aid during their whole existence; penetrating at once into the body of their host, they do not move, but lodge there from the cradle to the tomb.

It is only a few years since we did not suppose that a parasite could live in any other animal than that in which we found it. All helminthologists, with few exceptions, regarded the intestinal worms as formed without parents in the same organs they inhabited. We had observed, even for a long time, the parasitic worms of a fish in the intestines of certain birds; we had even instituted some experiments to assure ourselves of the possibility of these passages,* but all these experiments had only given a negative result, and the idea that transmigration was necessary was so completely unknown, that Bremser, the first helminthologist of his age, accused Rudolphi of heresy when he stated that the ligules of fishes could live in birds.

---

* All the sexual Cestoids.

† Most of those worms called ectoparasites, as the Tristomas, etc.

At a period nearer ours, our learned friend Von Siebold, called with good reason the prince of helminthology, shared more completely this opinion, in referring the Cysticercus of the mouse to the Tænia of the cat, but regarding this young worm as a stray, sick and dropsical being. To his eyes the worm had made a false journey into the mouse; the Tænia of the cat could only live in the cat. Was Flourens romancing when I announced to the French Institute that it was necessary for these cestoid worms to migrate from one animal to another in order to pass through the phases of their development?

At present in the zoological institute we daily repeat with the same success experiments on these transmigrations, and lately our learned friend R. Leuckart, who directs with so much talent the Institute of Leipzig, has discovered, in company with his student Metznikoff, some transformations of worms accompanied with a change of sex; that is to say, they have seen some Nematoid parasites of the lungs of frogs, either always females or hermaphrodites, produce males and females which bear no resemblance to their mother, and whose habitual abode is not in the lungs of the frog, but in humid earth.† Here we have a female, born a widow, who cannot live without aid, and who brings forth sons and daughters able to take care of themselves. The mother is parasitic and viviparous, the children are, for their whole lives, free and oviparous.

This leads us to that other sexual peculiarity, lately observed, of different males and females in one and the same species, which give birth to young which do not resemble them: the same animal or rather the same species arises from two different eggs, fecundated by different spermatozoids.[*] Though these transformations are to-day perfectly known and believed, yet naturalists quite often attribute the honor of this discovery to our confréres who have not known that the demonstration had been entirely made and that the new interpretation was generally accepted. But to return to our subject. Aid is thus as varied as we find in our own world: to one is furnished the domicile,[†] to others the table,[‡] and to a certain number a livelihood in lodgings.[§] It is a complete system of lodging and subsistence, besides the best arranged philozoic institution. But if on the part of these paupers, we see that they render each other mutual aid, we should not regard them as wholly parasites or commensals. We believe we should be more just in calling them *mutualists*, and mutualism reclaims a place, as we have before said, by the side of commensalism and of parasitism. It will be necessary also to find a qualification for those which, as certain crustacea and even birds, are *spongers* or *sharks*[‖] (*des pique-assiette ou des écornifleurs*) rather than parasites; and for others which pay for the aid rendered them by malicious deeds.[¶]

---

* Abildgaard had seen some ligules (a species of intestinal worm) of fishes, in the intestines of the merganser duck. It is a fact that these worms do not die immediately after their entrance into a strange host.

† *Ascaris nigro-venosa*, and other Nematodes.

And how shall we designate those which, like the little plover of which we have already spoken, render a service that we may compare to medical assistance?

The plover indeed acts as a dentist to the crocodile, as a small species of frog acts as an accoucheur to his wife in using his fingers as forceps to bring forth the eggs into the world. And the beef-eater, does it not perform a surgical operation each time that it opens with its beak, the tumor on the back of the buffalo which contains a larva? It is an operator who pays for his keeping. Nearer at home we see the starling render in our fields the same service as the beef-eater in Africa; and can we not say that there is among these animals more than a specialty in the act of healing? We need not forget that the undertaker is a common personage in nature and that it is never without some profit to himself or his offspring that this sombre workman buries dead bodies.* There are even some animals not without some analogy with the shoeblack or the scourer and which perform with a certain sort of coquetry the toilette of their neighbors.†

---

[*] Insects, Crustacea and worms furnish examples. An Isopod, *Apseudes anomalus*, has two forms of males; the ordinary, or the more common, resembles the female. The Cumaceæ also have two sorts of males; the more common also resembles rather the female, and is found all the year, while the other is rarer, and only appears at certain epochs of the year. We observe the same phenomena in several other Crustacea, as the *Pontoporeia affinis*, *Cypridina teres*, *Cyprina Lilljeborgii* and the *Philomedes Mariæ*. These observations have been made by Sars. M. Lespès recognized two sorts of males and two sorts of females in *Termes lucifuga*; *Nereis Dumerilii* has likewise two sexual forms, the nereidian and the heteronereidian form. A nematode worm, *Leptodera appendiculata*, is a similar instance. For a long time we have known the existence of winter and summer eggs in the same animal.

[†] The Alepas and many others.

[‡] The leeches.

[§] The greater number of true parasites.

[‖] Piqui-bœuf et Milan parasite.

[¶] The ichneumons end by killing the larva which has given them life, after having eaten them piece by piece.

And how shall we designate those birds known under the name of *stercoraries* which profit by the meanness of gulls to live in idleness? The gulls surpass in their strength of wing; the stercoraries end by making them disgorge and share with them the profits of the fishery. Pursued too closely these timorous birds disgorge the contents of their crops to lighten themselves, as the smuggler who sees no other means of safety than in abandoning his load. We should not always ascribe these habits to the species as a whole, since in the mosquito it is only one of the sexes which seeks a victim. In general all these animals live from hand to mouth, and if there are some which know how to economize, there are likewise those which do not ignore the advantages of a savings bank.‡ Like the crow and magpie there are some which care for the morrow and save the overplus of the day.

We have spoken: this small world is not always easy to understand, and in these societies each one contributes his capital, some by industry, others by force or strategy, and he is more a man than a Robert Macaire who shares nothing at all and makes the most of everything not his own.§

Each kind of animal may have its parasites and commensals, and each animal may have even different kinds and various categories of them.

---

*Among insects the Necrophori are known, as the name indicates, to fill this rôle.

†The Caligi and Argulæ, etc., among Crustacea.

‡ The bees and all insects living in society.

§ The Dromias, Paguri, Cenobites, etc.

ON THE DISTRIBUTION AND PRIMITIVE NUMBER OF SPIRACLES IN INSECTS.[*]

BY A. S. PACKARD, JR.

WHILE engaged in dissecting certain Sphinx and Bombycid larvæ, my attention was called to an interesting feature in the distribution of the thoracic portion of the main tracheæ and their stigmatal branches. In the larva of Sphinx and of *Platysamia cecropia*, and in fact so far as I am aware in all lepidopterous larvæ, there are nine pairs of spiracles, or stigmata, of which eight are abdominal, there being a pair to each first eight segments of the abdomen; while there is but one pair of thoracic spiracles, which are invariably, so far as I am aware, situated on the prothoracic segment. On laying open the body of a Sphinx larva a large number of branches are seen to arise from the prothoracic and basal, or first pair of abdominal spiracles. Now between these two points it will be remembered that there are no spiracles or any external signs of them. And yet the main trachea between these two spiracles deviates from its course and bends down to send off a small trachea to the place where, did a spiracle exist, we should look for it, *i.e.*, to a point in the suture between the mesothoracic and metathoracic segments, where in hymenopterous larva a spiracle does exist. From the upper side of the main trachea two larger branches are sent towards the interior of the body. These apparently correspond with the numerous branches sent off from the spiracles.

In *Platysamia cecropia* the same disposition of the main trachea may be seen, as it bends out in the same way towards the usual site of the spiracle in other groups of insects, and throws off three branches, one outward towards the tegument, small, and apparently rudimentary, while the two others, directed inwards, are larger than in Sphinx.

This has led me to ascertain how the spiracles are distributed in other groups of insects, and what is their usual number. While in the lepidopterous larvæ there is but one pair of stigmata, which are situated on the prothoracic, or first thoracic, seg-

---

[*] Read before the National Academy of Sciences, New York, November, 1873.

ment, in the larvæ of the higher Hymenoptera, *i.e.*, the bees and wasps (I have examined Bombus, Xylocopa, Halictus, Andrena, Vespa and Polistes), there are no spiracles on the prothorax, but a pair on each of the two following thoracic segments. In all these the thoracic spiracles are as well developed as those on the abdomen, and in Bombus larvæ the tracheæ proceeding from the spiracles are as well developed, being large and elongate barrel-shaped just after leaving the stigmata, and beyond subdividing into several branches. In two genera of Tenthredinidæ, and probably in the family generally, the spiracles are arranged as in the lepidopterous larvæ, there being but one pair, the prothoracic. In the Uroceridæ, however, Tremex in its larval state has two pairs, one prothoracic and one metathoracic, the anterior pair twice as large as the posterior pair. So it would seem that while no known hymenopterous larva has more than two pairs of spiracles on the thorax, yet three pairs may be found on different rings in different groups, though not actually existing in one individual. The ideal number of pairs is three, or for the entire body eleven. In the Diptera the Cecidomyiæ have nine pairs of stigmata, of which one is thoracic (on the prothorax), while the eight other pairs are abdominal. In the Muscidæ, there are two pairs only, one prothoracic, the other anal, or situated on the ninth segment of the abdomen. So that in this group we have ten segments which bear spiracles, though no single species is known to have more than nine pairs of spiracles.

In the Coleoptera there are usually nine pairs of spiracles, one thoracic, and eight abdominal. The thoracic spiracles are either on the pro- or meso-thoracic segment.[*] In the adult Melolontha and other beetles Strauss shows that a spiracle exists between the meso- and meta-thorax, which is not present in the larva. If this be so, then the ideal number of pairs in Coleoptera is ten.

In the Hemiptera and Orthoptera[†] there are two pairs of thoracic spiracles present on the two anterior segments; and in the Neuroptera[*] there are the same number, but none on the prothorax.

---

[*] It is often difficult to say on which segment of the coleopterous larvæ the thoracic spiracles are placed, they are so near the suture separating the pro- and meso-thoracic segment, and authors differ considerably about them. In the larvæ of Carpophilus, Cetonia (by some they are stated to be on the meso-thoracic ring), Anobium, Tomicus and Xanthochroæ the spiracles are said to be placed on the prothoracic ring (Candez). In Magdalinus they are situated on the suture between the segments, and in the Longicorns they are in some genera placed on the posterior edge of the prothoracic, and in others on the anterior edge of the meso-thoracic ring.

[†] Gryllidæ and Acrydii (Dufour).

In the larva of *Corydalus cornutus* there is a pair of spiracles on the prothorax, but they are no larger than those on the basal segment of the abdomen. It is difficult to say whether they are situated on the prothoracic or mesothoracic segment, but I am inclined to regard them as placed on the extreme hind edge of the prothoracic ring.

A curious fact may be here mentioned, as I have not seen it noticed before, regarding the distribution of the tracheæ in the larva of Corydalus. The main tracheæ suddenly enlarge from the second abdominal spiracle to the base of the head, when it subdivides and distributes branches to the head. From the spiracle on the basal abdominal segment a trachea, as large as the anterior swollen portion of the main trachea, takes its origin and passes directly under the main trachea. Now both tracheæ send a branch opposite to where the mesothoracic stigma should be, if present, *i.e.*, on the hind edge of the ring. Both branches of the tracheæ, the main one and its fellow, anastomose perfectly over the branch sent off to the prothoracic spiracle.

This doubling of the tracheæ, which are so very large, forms evidently an hydrostatic, as well as respiratory, organ and serves to lighten the anterior and heavier portion of the body, as in the dilated air sacs of the terrestrial insects. This fact seems to sustain the view of Gegenbaur,[†] that the tracheæ were at first closed, forming air-bladders, and afterwards performed the function of respiration.

It would appear from these facts that while no more than ten pairs of spiracles are to be found on the bodies of any one species of the groups of insects above mentioned, yet that eleven segments of the body, in different species taken collectively, bear them. Now if we turn to the Thysanurous genus Campodea, we shall find on the authority of Meinert that it bears spiracles on each thoracic segment. From this fact we are inclined to regard eleven as the normal primitive number of pairs of spiracles. Probably the larvæ of the different groups of winged insects had originally a pair on each thoracic segment. Certainly at least on evolutional grounds from the indications in existing caterpillars we are perhaps warranted in concluding that the ancestral type of lepidopterous larvæ was provided with two pairs of thoracic spiracles.

---

[*] There are two pairs of spiracles in the meso-thoracic and meta-thoracic rings respectively in the Libellulidæ and Ephemeridæ (none abdominal, as the larvæ have none), and in the Myrmeleons and Perlidæ.

[†] C. Gegenbaur, Gründzüge der Vergleichenden Anatomie, 2te Auflage, 1870. p. 437

GEOGRAPHICAL VARIATION IN NORTH AMERICAN BIRDS.*

BY J. A. ALLEN.

PROBABLY the birds of no equal area of the earth's surface are better known than those of North America north of Mexico, or of the whole continent southward even to the Isthmus of Panama. No museums in the world, probably, possess so large suites of specimens of single species as there are of North American birds in the Museum of the Smithsonian Institution and in the Museum of Comparative Zoology, nor from so many localities. In many instances single species are represented by hundreds of specimens collected at frequent intervals throughout their known range. Those contained in the Smithsonian Institution have been most carefully elaborated by Prof. Baird and others, whose reports upon them have justly acquired a world-wide reputation for their thoroughness and accuracy. Those in the Museum of Comparative Zoology have also been carefully studied.

Briefly, then, what are the facts and the general results that have followed the investigation of this exceptionally large amount of material? What are the allowable inferences, and what general principles have been apparently established? To answer these questions as briefly as may be is the object of the present remarks, — premising, however, that the formerly current opinions respecting the rank of a certain class of forms heretofore generally regarded as specific have been radically modified. Intergradation has been frequently traced between widely different forms, a gradual coalescence in scores of instances having been positively established, and rendered extremely probable in a large number of others.

In North America geographical variation exhibits two marked phases: — (1) a differentiation with differences of latitude and elevation, and (2) differentiation with differences of longitude; which, for convenience, may be termed respectively latitudinal and longitudinal variation.* In respect to both, differentiation occurs in different degrees in different groups, in accordance with their general tendency to variation, or, as it were, in proportion to their normal degree of plasticity. In regard to variation with latitude the modifications are apparently more general than in what I have termed longitudinal variation. In latitudinal variation the differentiation affects not merely color, but size and the details of structural parts, whereas color appears to be the main element affected by longitudinal variation. The fact of variation in size has been conceded as a general law by the majority of at least American ornithologists and mammalogists since it was so fully established by Prof. S. F. Baird in 1857 and 1858, in his admirable reports on the mammals and birds of North America, published in the series of Government Reports on the explorations and surveys of the various Pacific Railroad routes. Prof. Baird then and subsequently † called attention to the fact of the greater length of the tail in several species of birds at certain localities, and cites instances of the larger size of the bill at southern points, and the paler color of the plumage of the birds of the Plains and the arid peninsula of Lower California. All his subsequent works have furnished numerous citations of similar variation with locality, but instead of insisting upon any common tie connecting these phenomena as the result of general laws, they were viewed as evidences of specific differentiation. The differences are, indeed, so great between many of the forms now known to intergrade that it is not surprising that they were regarded as different species when known from only a few examples, apparently unconnected by intermediate forms. Subsequently, however, it has been found that they are not trenchantly separated, intermediate forms so linking them together that they can be only vaguely diagnosed. These connecting links, inhabiting — at least in the breeding season — localities intermediate in geographical position and in climatic conditions to those frequented by the more extreme forms, suggest an intimate genetic relationship and a differentiation mainly or wholly through climatic influence, or the diverse conditions of environment.

---

*From the Proc. Bost. Soc. Nat. Hist., vol. xv, p. 212.

Latitudinal variation presents the following phenomena, which are of such general occurrence that even the exceptions, if such there really be, are exceedingly few.

---

* See Bull. Mus. Comp. Zool., vol. ii, pp. 229-247, *et seq.*, April, 1871.

† Amer. Journ. Sci. and Arts, vol. xli, 1866.

1. *As regards Size.* There is a general reduction in the size of the individual from the north southward, amounting not unfrequently to as high as ten to fifteen per cent. of the maximum size of the species. The reduction is much greater in some species, and in some groups of species, than in others, but is almost invariably considerable and easily recognizable.

2. *In respect to the Bill.* The variation of the bill is somewhat inverse to that of the general size, as a rule the southern forms having generally relatively, and often absolutely, larger bills than northern ones, the increased size taking different proportions in different species and different styles of bill. Those of a stout, thick, conical form generally increase in general size, but especially in thickness. Those of a slender, attenuate form become slenderer and relatively longer at the southward, with a decidedly greater tendency to curvature.

3. *In respect to the Claws.* A similar increase in size is apparent in the claws, especially in that of the hallux, at southern localities, perhaps less marked and less general than the increase of the bill, with which it evidently correlates.

4. *In respect to the Tail.* A marked elongation of the tail at the southward has been noticed in many cases, both in Cape St. Lucas birds (*Baird*) and in those of Florida.

5. *In respect to Color.* The differences in color are especially obvious, and may be reduced to two phases of modification:—(*a*) a general increase in intensity at the southward, and (*b*) an increase in the extent of dusky or black markings at the expense of the intervening lighter or white ones; or, conversely, the reduction in size of white spots and bars. Under the general increase in intensity the iridescence of lustrous species becomes greater, and fuscous, plumbeous, rufous, yellow and olivaceous tints are heightened in species with the color continuous in masses. Under the repression of light colors the white or yellowish edgings and spots on the wings and tail become more or less reduced, and frequently to a great degree, in species barred transversely with light and dark colors; the dark bars widen at the southward at the expense of the white or lighter ones, sometimes to such an extent as greatly to change the general aspect of the species, as is the case in the *Ortyx virginianus* of the Atlantic States, and in other well known species. Also under the tendency to the increase of dark colors, longitudinal streaks and blotches on a light ground increase in extent and intensity of color.

In respect to longitudinal variation, the differences appear to be mainly those of color, and to hold a direct relationship to the humidity of the climate. On the arid plains of the middle and western portions of the continent the annual rainfall is less than half that of the eastern half of the continent, while a rainy belt occurs on the Pacific coast, stretching northward from near the mouth of the Columbia River to Alaska, over which the annual rainfall is double that of any portion of the eastern half of the continent. Taking the species that present a nearly continental range, we find that almost invariably they pass gradually into the pallid forms of the interior at the eastern edge of the arid plains, the greatest pallor being developed in the driest regions, as the peninsula of Lower California and the almost rainless belt along the Colorado River, and northward along the eastern base of the Sierra Nevada Mountains; that on the Pacific slope they again reassume nearly the tints of the eastern form, but more to the northward, over the above-mentioned rainy region, they acquire a depth of color far in excess of what the species presents in the Atlantic region. This coincidence of bright and pale tints, with the relative humidity of the locality is certainly suggestive, if not demonstrative, of the relation of cause and effect between these two phenomena, since the same rule is traceable, over large portions, at least, of the Old World; the Scandinavian forms, for instance, being darker colored than the conspecific races of Central Europe, and these again darker than those of Northern Africa and the adjacent regions. Humidity alone, or in conjunction with greater intensity of light, seems equally well to account for the increase of color to the southward. Yet, from the well known bleaching effect of sunlight, intensified by reflection, upon the colors of animals living upon sandy islands, and sea-beaches, and desert interior regions, it seems doubtful whether the larger share of modification in intensity of color in birds may not be due to humidity alone, or to humidity and a high temperature together, rather than to intensity of light.*

In regard to the enlargement of peripheral parts at the southward, it seems not unreasonable to suppose that the increase of temperature in stimulating the circulation in these exposed members may have something to do with it, especially in view of the evidence afforded by mammals, which in general present climatic modifications parallel with those of birds.

---

* See on this point further remarks by the same writer in Proc. Bost. Soc. Nat. Hist, vol. xvi, June, 1874.

Whatever may be the cause of the above modifications of structure and color at different localities, we certainly find the following coincidences: I. In accordance with the increase in the intensity of color in individuals of the same species from the north southward, in the northern hemisphere, the brighter colored species in genera represented in both the temperate and tropical regions occur, as a general rule, at the southward; the same fact holding good also for sub-families. In cosmopolitan genera, families, etc., the tropical species are almost always brighter colored than the extra-tropical ones. All the most gorgeously colored families of birds are either exclusively tropical or semi-tropical, with generally the outlying species more plainly colored than the average for the family. II. In accordance with the increase in the size of the bill at the southward, all the species that have this member enormously developed are tropical or semi-tropical, not only such families as have the beak at its maximum of development, as the toucans and hornbills, but in all groups in which it is unusually large, the extreme development is reached in the intertropical regions. III. In respect to the tail, with very few exceptions, all long-tailed forms attain the highest development of this member within or near the equatorial regions.

The facts indicated above, in respect to the inosculation of forms formerly regarded as specifically differentiated, will evidently require modifications of the hitherto accepted nomenclature. Evidently many of these forms are so strongly marked that they should be in some manner recognized in nomenclature, though admittedly of less than specific rank. Most naturalists now practically recognize as species such groups of individuals as are not known to graduate by nearly imperceptible stages into any other similar group; and as varieties, such groups of individuals as occur at certain localities, or over certain areas, which differ more or less from other groups inhabiting other (generally contiguous) localities, with which there is evidence that they do, more or less fully, intergrade. Convenience seems to demand such a course, in order to enable the naturalist to specify what particular variety or race of a species inhabits a given section of country — a method, in fact, already more or less generally practised.

Finally, what is the bearing of these facts of geographical variation upon the question of origin of genera and species? Having approached the subject from a geographical standpoint, my own impression of the importance of the conditions of environment in modifying the characteristics of animals may have unduly impressed me; yet that they exercise a greater influence than is currently recognized I think must be admitted. How, for instance, can natural or sexual selection satisfactorily account for the occurrence of pallid forms in arid, semi-desert regions, and of brighter colored forms in contiguous humid districts, or the generally increased intensity of color southward, and its maximum development only toward and within the tropical regions? In many cases, it is true, the change in color may be protective, as it doubtless is in the assimilation of the pale tints of birds and other animals inhabiting arid plains to the generally gray color of the vegetation and the earth itself in such localities; yet, as the resemblance of the birds of these arid districts when young or in fresh plumage to those of the adjoining regions at the same season is much greater, as a general rule, than at the end of the breeding season, we have thus palpable evidence of the direct modification of color by environing conditions. Again, it is hard to see how the intenser and darker shades of the iridescence of the *Quiscali* in the South Atlantic and Gulf States, or their slenderer and more decurved bill, or the greater breadth of the transverse black bars on the breast of the southern form of *Ortyx Virginianus* can be in the one case any more "protective," or in the other give greater facility in obtaining food, than the different colors and the differently proportioned beaks of the northern forms of these species; or of what advantage the large claws and long tails can be at southern localities rather than at northern. The variation in color is not apparently any better explained by sexual selection than are the other modifications by natural selection, for it is hardly supposable that sexual selection should act in so uniformly an accelerated degree toward the southward, or so generally from arid regions toward moister ones. On the contrary, it is just this gradual and general modification over wide areas that apparently points to climatic influence as the differentiating cause. There is, further, frequently a closer assimilation of the sexes at the southward, as among the *Icteridæ*, through the greater increased brilliancy of the female as compared with the male, which is rather the reverse than otherwise of what is commonly supposed to be the result of sexual selection.

Freely admitting, however, that both natural selection and sexual selection are causes of modification in the gradual differentiation of animals, I am led to regard them as secondary rather than primary elements, and that climate and other environing conditions take a larger share in the work than the majority of evolutionists seem willing to admit. Evidently no single law will explain all the phases of modification by descent, and in addition to those above alluded to, doubtless what Hyatt and Cope, among American zoologists, have termed the laws of acceleration and retardation are among the other causes of the modification. In birds, even, phenomena are apparent that cannot be strictly admitted into the category of geographical or climatic variations, but seem singularly to combine some evident features of this character with a retention of a few embryonic characteristics, especially in respect to coloration, of allied intergrading forms, as occurs in some of the birds of the middle portion of the North American continent as compared with those of the eastern portion. Again, in respect to insular regions, while the above mentioned general laws of climatic variation are there evident, certain other exceptional modifications obtain, that seem specially to characterize those regions.

A word, in conclusion, respecting hybridity: — When comparatively few instances were known, in which specimens combined in various degrees the characters of two quite distinct forms, their synthetic character was generally explained by the theory of hybridity; but the irrefragability of the evidence now at hand in proof of the intergradation of such forms over large areas,— the transition being so gradual as to occupy hundreds of miles in the passage,— and also coincident with a similarly gradual change in the conditions of environment, together with the demonstrable evidence of the power of climatic influence, seems to furnish a far more satisfactory explanation of these perplexing phenomena. But an advocate of the theory of hybridity might still assume that this gradual transition over a wide area is no objection to the theory, since the gradual fading out of the impression of contact in either direction from the line of junction of the respective habitats of two forms is just the result that would be anticipated from such a sexual intermingling of the forms in question. But the real objection to the theory—granting the possibility of hybridization on such a gigantic scale, which seems really improbable—is, that widely different forms occur also at different points in latitude, between which each successive stage of gradual differentiation can be readily traced, where hybridity can scarcely be supposed to account for the gradual change. Furthermore, gradual differentiation is now known in so many cases that it amounts to the demonstration of climatic variation as a general law, by means of which a species may be safely predicted to take on a given character under certain specific climatic conditions. If the theory of hybridity be urged to account for the intergradation of forms occurring at localities differently situated in respect to latitude, as has sometimes been done, it evidently falls under the weight it has to support; and yet there seems to be little better evidence in its behalf in cases where the intergrading forms happen to be differently situated in respect to longitude.

To describe in detail, or even to give illustrations, of geographical modification would require more space than would be proper to use in this connection, especially since a preliminary exposition of the facts upon which the preceding generalizations have been based, has already been presented in two papers in the Bulletin of the Museum of Comparative Zoology (Vol. ii, No. 3, April, 1871, and Vol. iii, No. 6, June, 1872).

REVIEWS AND BOOK NOTICES.

RECENT PUBLICATIONS ON ORNITHOLOGY.—Like the pages of the NATURALIST with which our readers are of course sufficiently familiar, recent issues of nearly all our scientific institutions show notable activity in ornithology, and a number of papers have accumulated on our table. In the Philadelphia Academy's Proceedings, Mr. Thos. G. Gentry has described peculiarities in the nidifications of *Sayornis fuscus* (1873, p. 292) and *Vireo solitarius* (*op. cit.*, 354); Mr. B. R. Hoopes has published a new variety, *Krideri*, of *Buteo borealis* (*op. cit.*, 238, pl. 5) from Iowa, a pale race of the dry interior, apparently as distinct as some others now currently recognized. In the Boston Society's Proceedings (xvi, 1873, 106), Dr. Brewer has continued the development of Lt. Bendire's Arizona oölogical collections, which was begun in the NATURALIST (June, 1873, 321) describing several varieties or novelties. The identifications appear to be correct, excepting that of *Carpodacus Cassinii* which should, we believe, stand as *C. frontalis*, and that of "*Myiadestes Townsendii*," an evident slip of the pen for *Phænopepla nitens*.

Dr. Brewer has also a brief notice of the North American *Hylocichlæ* (Pr. B. S. N. H. xvi, pt. ii), in which he takes the ground that there are eight species of this subgenus, a view at variance with that now commonly accepted by ornithologists, who reduce the number to four or five. For ourselves, we concur more nearly with the mode in which the several forms are handled in the late work of Messrs. Baird, Brewer and Ridgway.

The important business of cataloguing the Boston Society's collection of birds, ably begun by Mr. A. Hyatt, has been carried on by Mr. R. Ridgway, who has gone carefully over the series of *Raptores*, identifying the specimens and naming them upon his protracted and favorably known studies of this group. His paper (Pr. Bost. Soc. xvi, 1873, 43), though simply a catalogue, becomes at once an authority, and places the collection upon a more satisfactory basis than it has hitherto rested upon. We wish that arrangements could be made for him to go over the Philadelphia Academy's *Raptores* in like manner; it is a very desirable piece of work, which must be done some day, and we know of no one more competent to do it. The article is supplemented with monographs of the genera Micrastur, Geranospiza, Rupornis and Glaucidium, worked out with the same patient care and to the same extent of analytical detail which have marked his previous labors. Without here entering upon a criticism of certain determinations, as some of those in the genus Micrastur, which will require remodelling, we may witness the extent and importance of his investigations in these groups.

The same author has lately cleared his desk of several additional papers, giving as the benefit of much study, the results of which are only now become apparent. The most notable of these (Essex Inst. Bull. v, 197) describes a number of new forms of North American Birds, from his own and Prof. Baird's manuscripts. The descriptions are virtually of one parcel with those lately published in the NATURALIST, in advance of the great work of Messrs. Baird, Brewer and Ridgway, partly in courteous accommodation of ourselves, in order that the names might become available for our "Check List," then in press. Some twenty-five new names are proposed all together, mostly varietal.

Mr. Ridgway's fourth and fifth papers are local lists of the Birds of, respectively, Colorado and the Salt Lake Valley. The first of these is a digest of the previous literature upon the subject, together with the large amount of material gathered by, more particularly, Mr. C. E. Aiken; it comprehends the birds of the whole territory. The last named may be regarded as in some measures complementary to Mr. J. A. Allen's recent 'Reconnoissance' (Bull. Mus. Comp. Zool., iii, 1872), Mr Ridgway's investigations having been conducted from May until August, while Mr. Allen's were autumnal. The two together go very far towards completing our knowledge of the presence and movements of the species within the region mentioned.

In evidence of the great activity of research at present in the southwest, may be instanced an additional local list by Mr. H. W. Henshaw, giving a résumé of the ornithological results of his season's connection with the Wheeler Explorations west of the 100th meridian. The ground covered is partly what we went over in 1864–65, which has been latterly reworked by Lt. Bendire, U.S.A. The list is confined to Mr. Henshaw's own observations, and may be regarded as perfectly reliable, not only in the identifications of the species, now contained in his beautiful collection, but in the observations upon their movements and relative frequency.

Returning to Mr. Ridgway's contributions to ornithology, we have next to note an important paper (Ann. Lyc. N. Y. x, 1874, 364) upon the birds of Illinois, with one exception the first article bearing upon the whole subject. Mr. R. H. Holder's paper (Trans. Ill. Agric. Soc. iv, 1859–60, 605; 247 species, minus two not valid) was a simple enumeration, and, though excellent as far as it went, lacked the essential qualifications of discriminating the several categories of residents, migrants and stragglers. Kennicott's contributions (*op. cit.*, i, 580; 187 species) were confined to Cook county, and to a supplement of 22 species to Henry Pratten's list of the Birds of Wayne and Edwards counties (184 sp.+22=206; *op. cit.*, 596) with the addition of *Plotus anhinga* and *Tantalus loculator* (Pr. Bost. Soc. v, 1856, 391). With the exception of a paper which we have not seen, by F.

Brendel (Giebel's Zeitsch. 1857, 420), and Mr. Allen's Notes on the Birds of Northern Illinois (Mem. Bost. Soc. i, 1868, 502; 94 species), no other formal papers on the subject have appeared to our knowledge, though Mr. Ridgway himself has twice communicated short pages to the NATURALIST (vi, 1872, 430; 4 rare species; and Apr., 1873). The present list, occupying thirty pages, gives 311 species certainly occurring, with 43 "probabilities," representing a total of nearly 350 species, constituting the probable avifauna of the state. Of these 176 are known to breed. The two families, Sylvicolidæ and Fringillidæ, head the list with no fewer than 36 species apiece. The Anatidæ follow with 34, the Scolopacidæ with 25, and the Falconidæ with 20. Sixteen families have but a single Illinois representative; the remainder average about five species to a family. All the North American families excepting Chamæidæ, Procellariidæ and Alcidæ occur in the State. Among the breeders, the Sylvicolidæ and Fringillidæ are as before best represented with respectively 21 and 16 species. Lake Michigan furnishes a large quota of the stragglers, among waders and swimmers. Several species occur not hitherto attributed to the State, and the number of rarities is quite large. Being based upon personal observations, as well as upon a command of the published literature of the subject, and possessing the best qualities of a local list, the present paper at once becomes the authority, superseding the previous incomplete records. We notice considerable nomenclature to which we are unaccustomed, but this matter scarcely requires criticism in a paper having no special classificatory object; though we must demur at what seems to us, in some instances, a forced reduction to varieties of accredited species upon some theory, perhaps, of varietal relations with European forms whose intergradation with ours remains to be proven. It is unsafe to presume in such cases, or even to argue from analogy; nor can we say, at present, that a certain amount of observed difference shall be held specific, and another amount only varietal; we want to see the links.

We have an ornithological paper from a comparatively new quarter, by a writer of whom we have not before learned in such connection. In preparing a Report on the Birds of Minnesota (Bull. Minn. Acad. Nat. Sc. i, 1874, 50) Dr. P. L. Hatch does not appear to have availed himself of Mr. T. M. Trippe's late Communication (Bull. Essex Inst. vi, 1871, 113), nor of Dr. J. F.

Head's earlier article (Smith. Rep. 1854, 291). The list includes 230 species, being thus more nearly complete than either of its predecessors, one of which gave 60, the other 138. This number is so near the presumed maximum, that on casually looking up the subject from our own notes we find only about 20 species to be added. Still fewer species should be erased, though there are several we regard as uncertainties, like *Contopus Richardsoni* and *Empidonax pusillus*, while others, as *Archibuteo Sanctijohannis* (given in addition to *lagopus*) and *Nyctale albifrons*, are purely nominal. As usual with scientific printing in a new place, typographical errors are too frequent. It is the most satisfactory enumeration of the birds of this state we have had, while its value as a mere catalogue is much increased by the running commentaries, giving items on the period of occurrence, breeding, relative numbers, etc., of the species, as well as, in many instances, brief notes of habits.

We have not yet reached the number of the faunal lists before us. A long expected paper of great consequence has just appeared in the Memoirs of the Boston Society (ii, 1874, pt. iii, No. II, pp. 265–319); we refer to Mr. G. N. Lawrence's "Birds of Western and Northwestern Mexico." This is based upon the manuscripts and collections of the late Col. A. J. Grayson, of Mr. J. Xantus and Mr. F. Bischoff, placed by the Smithsonian Institution in Mr. Lawrence's hands for elaboration. The collections together represent 316 species, of which not a few were novelties, recently described by Mr. Lawrence, in the Annals of the New York Lyceum and the Proceedings of the Boston Society. The largest and most valuable were made by Col. Grayson, chiefly in the vicinity of Mazatlan. The paper is enriched with copious field notes, Col. Grayson having intended to prepare a full history of the Birds of Western Mexico, with many colored plates of life size — an enterprise most unfortunately cut short by his lamented death. Mr. Lawrence observes that "as a field naturalist he should take rank with Audubon;" and presents extracts of his writings, "exceedingly graphic and of great value, as they elucidate the economy of many species, of which, comparatively, but little was heretofore known." We trust it may not be long before Mr. Lawrence will further elucidate the ornithology of Mexico, with the results of his examination of Sumichrast's Tehuantepec collections, upon which he has been engaged.

Messrs. Jordan and Van Vlieck publish at Appleton, Wisc., in small 4to, a Popular Key to the Birds, Reptiles and Fishes of the Northern States. When the emended edition of this praiseworthy endeavor to unlock this portion of our fauna to students is issued — we understand a revision is contemplated — we trust we may be authorized by the merits of the publication to speak of it more highly than we can at present.

Though somewhat foreign to our present purpose, reference in this connection to Prof. Reinhardt's continued studies on the osteology of Water-birds (Aft. Vid. Medd. Nat. For. Kjöb., 1873, 123) may not be wholly out of place, as we are convinced of the particularly important bearing such investigations have upon the classification of the future. In the late paper referred to, the wing-structure of Procellariidæ is treated with reference to the presence of the one or two supplementary ossicles of the elbow-joint, developed in connection with the "apophyse crochue" of the humerus, and the origin of the *extensor metacarpilongus* and *extensor plicæ alaris* (*tensor patigii* of some authors). He finds the bones in six genera and not in eight; but as the six are the richer in species, it is present in about two-thirds the species of the family. They are peculiar to the family, though other *Longipennes*, as well as Alcidæ and Limicolæ have the humeral hook. He points out their function, and proposes to divide the group primarily upon them. — ELLIOTT COUES.

HISTORY OF NORTH AMERICAN BIRDS.*—The announcement of a work on the ornithology of North America, by the above-named gentlemen, is in itself a guarantee of its interest and scientific value; and the three volumes now published fully satisfy such expectations.

A work of this character, always welcome, is particularly opportune at this time, as the need of a comprehensive "History of North American Birds" has long been felt. For nearly a third of a century from the publication of Audubon's "Birds of America," in 1844, until the present year, no such book has appeared.† As long ago as 1858, the numerous Government expeditions had accumulated so great a mass of material as to necessitate its publication, forming the well-known ninth volume of Pacific Railroad Reports. This was almost entirely technical, and limited to classification and description. Since this date many new species have been discovered and much additional information acquired, which find expression here, together with a résumé of everything of value previously published. The typography is all that could be desired, and misprints are noticeably few in number. The illustrations are excellent, and comprise a full length figure and outlines of the bill, wing, and foot of at least one species of each genus; and sixty-four plates representing the head, for the most part of life size, of each species. Volume I begins with an introduction giving the general anatomical characteristics of Aves, and their classification. Under the first family, or Turdidæ, are included sixteen species and seven varieties. Two only (*T. Pallasi*, with var. *nanus* and var. *Auduboni*, and *T. Swainsoni* with var. *ustulatus*) are found from ocean to ocean, being modified in certain regions as above. *Turdus confinis* is united to *migratorius* as a variety; and *T. iliacus* of Europe is admitted into our fauna, having been twice obtained in Greenland.

---

* A History of North American Birds, by S. F. Baird, T. M. Brewer and R. Ridgway. Land Birds. 3 vols., large 8vo. Boston, Little and Brown.

† We exclude numerous monographs and more or less local lists; and also certain works, which, while valuable in themselves, contain little or nothing in regard to general and breeding habits.

Harporhynchus Lecontei and *longirostris* are given as varieties respectively of *H. redivivus* and *rufus*. *Phyllopneuste Kennicotti* Baird is a synonyme of *P. borealis* Blasius, the latter name having priority; it is a Northeastern Asian species, accidental in Alaska and perhaps in Europe (Heligoland). *Saxicola œnanthe* is now recognized as by no means rare in the northern parts of our continent, where it seems to become more abundant yearly. *Regulus Cuvieri* Aud. is included; a second specimen, together with the nests and eggs of the two common species, are still desiderata. The Parinæ comprise twelve species and three varieties, of which the latter two (*P. septentrionalis* and *occidentalis*) are races of *atricapillus*. Sitta includes three species only, *S. aculeata* being given as a variety of *Carolinensis*, and *pygmæa* (III, 502) as "probably a geographical form of *S. pusilla*." Our Creepers are regarded as *Certhia familiaris* var. *Americana* and var. *Mexicana*. Here, as in many other parts of the present work, the tendency to unite as races the closely allied forms of Europe and North America is shown, and, in our estimation at least, most judiciously. In regard to the present species we can say from careful personal observations, that the habits and notes (including the "very distinct and varied song") are almost precisely identical both in this country and in Europe.

Thryothorus Berlandieri is united to *Ludovicianus* as a variety; and *Troglodytes Parkmanni* with *aedon*. *T. Americanus* Aud. is stated to be *aedon* "in dark, accidentally soiled plumage." *T. hyemalis* and *Alascensis* are given as geographical races of the European *T. parvulus*. *Motacilla alba* of Europe, like *Turdus iliacus*, has been twice obtained in Greenland, and more frequently in Iceland, and is therefore described. A third common European species, *Anthus pratensis*, has also been procured in Greenland, and more recently in Alaska.

Pages 177–325 are devoted to the Sylvicolidæ, and form a very interesting section. Fifty-two species and three varieties are enumerated, the genus Dendroica claiming twenty-three species. *Geothlypis Macgillivrayi* receives a distinct article on pp. 303–305; but on p. 297, and also in the appendix (III, 507), it is stated to be a geographical race of *G. Philadelphia*.

Icteria longicauda is given as a western form of *virens*. Thirteen species of Vireo, with three varieties *V. gilvus* var. *Swainsoni*; *V. solitarius* var. *Cassini* and *plumbeus*) are described. On pp. 363 and 364, *V. olivaceus* is stated to have occurred in England; but it is somewhat questionable whether the specimen obtained was not *V. altiloquus*.*

The number of North American shrikes has been reduced to two, *Collurio borealis* and *C. Ludovicianus*, with var. *robustus* (=*elegans*, Baird nec Swainson) and var. *excubitoroides*. On pp. 426–428 is given a synopsis of the Certhiolæ, several of which (besides *C. Bahamensis*) may very possibly occur as stragglers in the southern extremity of Florida.

Pyranga Cooperi Ridgway, is united to *P. æstiva*, and our pine grosbeak to *Pinicola enucleator* of Europe. *Pyrrhula Cassini* Baird is "a well marked and distinct species," and not a variety of the European *P. coccinea*; it is a Siberian species accidental in Alaska, and has been once obtained in Belgium. *Loxia Americana* and *Mexicana* are united to *curvirostra* as varieties, and (I, 483) *L. leucoptera* to *bifasciata*; but in the appendix (III, 509) the latter are separated as "entirely distinct" species. The determination of our species of Ægiothus is as follows:—I. *A. canescens* of Greenland, with var. *exilipes* of continental Arctic America; II.

---

* See a paper by Bree, in the London "Field," May 14, 1870, p. 417.

A. linarius of continental N. A., with var. *Holbölli* of Greenland in summer and continental N. A. in winter; III. *A. flavirostris* var. *Brewsteri*. *Leucosticte griseinucha* is united to *tephrocotis* as a variety, as are three others, *campestris* Baird, *littoralis* Baird, and (III, 509) *australis* Allen. The validity of *Passerculus princeps* Maynard, as distinguished from *Centronyx Bairdi*, is confirmed. *Passerculus alaudinus*, *Sandwichensis*, and *anthinus* are considered to be geographical forms of *P. savanna;* and *P. guttatus* is united to *rostratus*. In the Appendix (III, 513), speaking of the fact that *Coturniculus Lecontei* is intermediate between *C. Henslowi* and *Ammodromus caudacutus*, Prof. Baird remarks that "this renders it necessary to unite Ammodromus and Coturniculus into one genus, recognizing them as subgenera, definable chiefly by the different style of coloration of the superior surface in the two groups," the name Ammodromus having priority.

In the same appendix, p. 516, the capture in California of a specimen intermediate between *Passerella iliaca* and *Townsendi* is said to render it "extremely probable that all the known forms of this genus are but geographical races of one species."

To *Melospiza melodia* are allotted six varieties. *Alauda arvensis* of Europe claims admission, it having been captured in Greenland and Bermuda; and it has also been introduced in the vicinity of New York City, apparently with success. *Eremophila cornuta* "appears to be absolutely identical" with *E. alpestris* of Europe, which latter name has priority. *Sturnella neglecta* is united to *S. magna* as a western race.

Sturnus vulgaris, having been once obtained in Greenland, is included. The raven of North America is considered to be a race of the European *C. corax*. Another judicious change is the referring of *Pica Hudsonica* and *Nuttalli* to *P. caudata* as varieties; *Nuttalli* being regarded as a local aberrant form of *Hudsonica*, differing chiefly in its yellow bill. The difficult family of Tyrannidæ receives a careful and interesting review. *Contopus Richardsoni* is given as *virens*, var.; and *Empidonax Trailli* as *pusillus*, var. *Chordeiles Henryi* is considered to be a western form of *C. popetue*.

Of humming birds ten species are described, including the doubtful *Thaumatias Linnæi*. *Lampornis mango* is mentioned in a foot note only.

The number of valid species of woodpeckers has been considerably reduced, only twenty-three being enumerated, including *Colaptes hybridus*, and omitting *Campephilus imperialis* as extralimital. *Picus Canadensis*, *Harrisi* and *Auduboni* are united to *villosus* as varieties; *Gairdneri* with *pubescens; Picoides Americanus* with *tridactylus* of Europe; *Sphyrapicus nuchalis* and *ruber* with *varius*. On p. 588, vol II, speaking of *Conurus Carolinensis* and the singular confusion, still existing in regard to its breeding habits, etc., Prof. Baird remarks that "in view of their very limited area and rapid diminution in numbers, there is little doubt but that their total extinction is only a matter of years, perhaps to be consummated within the lifetime of persons now living."

The third volume begins with the Raptores, the systematic portion of which is by Mr. Ridgway. Here, again, many of the allied boreal forms of North America and Europe are united as geographical races of the same species, and in our opinion with great justice.* Fifteen species of owls are enumerated. It seems to be definitely settled that *Nyctale albifrons* Cassin is the young of *N. Acadica*. Three principal varieties of *Scops asio* are given: *Floridana*, *Maccalli* and *Kennicotti*. The dimorphic condition of this species and *Glaucidium ferrugineum* (as well as other extralimital species) is well compared to the melanistic state of certain hawks, in the one case reddish, in the other a more or less deep sooty brown being the color. *Spheotyto hypogæa* of North and Central America is given as a race of *S. cunicularia* of South America.

The Falconidæ comprise thirty-one species. The same general rule applies to the allied races of hawks as well as owls of Europe as compared with those of North America, namely, that in the latter the size is greater and the color much darker. This entire division is particularly interesting, many new facts in regard to the breeding habits, etc., of these birds, brought to light by several recent travellers in the Northwest, being published here for the first time. The synonymy of the North American gerfalcons

---

*For example, the following are now given as the specific names of certain of our species: — *Nyctale Tengmalmi* var. *Richardsoni; Nyctea Scandiaca* var. *arctica; Glaucidium passerinum* var. *Californicum; Falco lanarius* var. *polyagrus; F. communis* var. *anatum; F. lithofalco* var. *columbarius; Pandion haliaetus* var. *Carolinensis; Circus cyaneus* var. *Hudsonicus; Astur palumbarius* var. *atricapillus; Aquila chrysaetus* var. *Canadensis*, etc.

is given as follows:—I. *Falco* (*Hierofalco*) *gyrfalco* Linn., var. *candicans* Gm. (= *Groenlandicus* Daud.) of Greenland, wandering into Europe and North America; II. var. *Islandicus* Sabine, of Europe, Iceland, Greenland and North America; III. var. *sacer*, Forster, of interior of continental Arctic America; IV. var. *Labradora* Aud.

On page 254, a figure of the curious *Onychotes Gruberi* Ridgw. is given. *Buteo oxypterus* is united to *Swainsoni*, and *B. elegans* to *lineatus*. The American rough-legged hawks (excepting the western *Archibuteo ferrugineus*) are given as one species, and that a variety (*Sancti-johannis*) of the European *A. lagopus;* the melanistic condition being now correctly regarded as a frequent though purely individual peculiarity, like albinism. *Haliætus albicilla* of Europe is included on account of its occurrence in Greenland. On page 329 it is stated that "the 'bird of Washington' of Audubon was, without the least doubt, a very large immature female (of the bald eagle) in about the second year." It is to be hoped that this question is now finally settled.

The true *Meleagris gallopavo* is described as inhabiting the eastern province of North America, with var. *Mexicana* found from Texas and Arizona south into Mexico. The latter race is now considered to be the origin of the domesticated turkey.

Canace Franklini is united to *Canadensis* as a variety; *C. fuliginosus* and *Richardsoni* to *obscurus;* and *Bonasa umbelloides* and *Sabini* to *umbellus*. Three species of Ptarmigan are enumerated:—I. *Lagopus mutus* var. *rupestris* of Arctic America, Greenland and Iceland; II. *L. albus*, common to Europe and North America; III. *L. leucurus* of Northwest America. Audubon's *L. Americanus* is united to the first species.

In the Appendix are given a number of new facts in regard to the habits, distribution, and synonymy of species previously considered, and one or two new species are added, as *Harporhynchus Bendirei* Coues, *Setophaga picta*, *Peucæa carpalis* Coues, etc. It may here be remarked that while certain species are noted as having been obtained in Europe, as *Galeoscoptes Carolinensis*, *Dendroica virens*, *Progne subi*, *Loxia leucoptera*, *Sturnella magna*, etc., similar mention is made of others whose claims to such notice are equally good, as *Turdus migratorius*, *Coccygus Americanus*, *Harporhynchus rufus*, *Regulus calendula*, and a few others. A glossary of technical terms closes the volume.

In concluding this imperfect sketch we would only add that for years this will be the standard work on the ornithology of North America, and that the volume or volumes on "Water Birds" will be looked for with much interest by students and others interested in the birds of our country.— J. S. MERRILL.

BOTANY.

DISTRIBUTION OF ALPINE PLANTS.—M. De Candolle delivered at the late Botanical Congress at Florence a communication on the causes of the distribution of rare plants on the Alps. The author (M. De Candolle) explained that the preglacial Alpine flora was not able to exert a great influence on the existing flora, inasmuch as the great changes which took place during the glacial period had necessarily swept away this ancient vegetation. He could not agree with those who considered the Alps as a centre of diffusion of a special flora, but believed them rather to be the refuge ground for the plants, which, as the glaciers retired, had found conditions more favorable to their existence than in places lower down. In proof of this he observed that the richest parts of the Alps for rare plants are those which were soonest deprived of glaciers, the ground having been thus cleared for the introduction of a more ancient flora, of which these rare plants are remnants. The southern, the eastern, and the western slopes of the Alps were successively cleared of the principal glaciers, and the Swiss Alps received their flora first from the south, and then from the east and west. The author then asks, "Why should the plants ascend as the glaciers retreat, and why should there be greater variety in this advancing vegetation?" In preglacial times there was more moisture in the climate of Europe, and consequently the flora was richer and more varied. After a time the climate became drier, and as the glaciers retired many plants were able to maintain themselves by advancing gradually over the ground as it became unoccupied by glaciers, finding there conditions more favorable for their growth. Hence one can deduce the law that the richness and variety of Alpine floras depend on the antiquity of their introduction.

Mr. Ball approved of M. De Candolle's theory to a certain extent, but he did not consider it sufficient to explain all the facts. When, for instance, a rare species is to be found in more than one locality, it is natural to suppose that formerly it had occupied all the intermediate ground, and that the glacier coming through the midst of it had divided it into two groups. He was also unable to understand how M. De Candolle's theory could explain the fact of certain plants growing vigorously in limited spots without extending their area, and was inclined to attribute this limitation to the nature of the rock, its chemical properties, etc., — serpentine, for instance, almost always supports a peculiar vegetation; thus the Engadine Valley, which must have very recently been freed from glaciers, is remarkably rich in rare plants.— M. Tchiatcheff remarked that in Asia Minor he could find no trace of glacial action which could help to explain the distribution of Alpine plants.— *Journal of Botany*.

AMOUNT OF WATER CONTAINED IN THE DIFFERENT PARTS OF A PLANT.— At the same meeting M. Galeznoff gave the result of his researches in calculating the amount of water contained in the different parts of a plant. By dividing a trunk into a number of pieces from the base upwards, he found invariably that the quantity of water increases from the base towards the summit. Of the four species studied by him, he found *Pinus sylvestris* contained most moisture in the trunk, and Acer the least. Betula and *Populus tremula* were intermediate. In Pinus the bark is drier than the wood, and in Acer more moist. In Betula it is drier in the winter and spring, and more watery in summer and autumn. The contrary takes place in the case of the poplar. In the branches the same law holds good but their bases are drier than the portion of the trunk from which they take their rise; and the petioles are more watery than the leaves. In the flowers, the perianth, the filaments and the styles contain more water than the anthers. — *Journal of Botany*.

ZOOLOGY.

RECENT RESEARCHES ON TERMITES AND STINGLESS HONEY-BEES. — The accompanying letter, just received from Fritz Müller, in southern Brazil, is so interesting that it appears to me well worth publishing in "Nature." His discovery of the two sexually mature forms of Termites, and of their habits, is now published in Germany; nevertheless few Englishmen will have as yet seen the account.

In the German paper he justly compares, as far as function is concerned, the winged males and females of the one form, and the wingless males and females of the second form, with those plants which produce flowers of two forms, serving different ends, of which so excellent an account, by his brother, Hermann Müller, has lately appeared in "Nature."

The facts, also, given by Fritz Müller with respect to the stingless bees of Brazil, will surprise and interest entomologists.—CHARLES DARWIN.

"For some years I have been engaged in studying the natural history of our Termites, of which I have had more than a dozen living species at my disposition. The several species differ much more in their habits and in their anatomy than is generally assumed. In most species there are two sets of neuters, viz., laborers and soldiers; but in some species (*Calotermes* Hag.) the laborers, and in others (*Anoplotermes* F. M.) the soldiers, are wanting. With respect to these neuters I have come to the same conclusion as that arrived at by Mr. Bates, viz., that, differently from what we see in social Hymenoptera, they are not modified imagos (sterile females), but modified larvæ, which undergo no further metamorphosis. This accounts for the fact first observed by Lespès, that both the sexes are represented among the sterile (or so-called neuter) Termites. In some species of *Calotermes* the male soldiers may even externally be distinguished from the female ones. I have been able to confirm, in almost all our species, the fact already observed by Mr. Smeathman a century ago, but doubted by most subsequent writers, that in the company of the queen there lives always a king. The most interesting fact in the natural history of these curious insects is the existence of two forms of sexual individuals, in some (if not in all) of the species. Besides the winged males and females, which are produced in vast numbers, and which, leaving the termitary in large swarms, may intercross with those produced in other communities, there are wingless males and females which never leave the termitary where they are born, and which replace the winged males or females, whenever a community does not find in due time a true king or queen. Once I found a king (of a species of *Eutermes*) living in company with as many as thirty-one such complemental females, as they may be called, instead of with a single legitimate queen. Termites would, no doubt, save an extraordinary amount of labor if, instead of raising annually myriads of winged males and females, almost all of which (helpless creatures as they are) perish in the time of swarming without being able to find a new home, they raised solely a few wingless males and females, which, free from danger, might remain in their native termitary; and he who does not admit the paramount importance of intercrossing must, of course, wonder why this latter manner of reproduction (by wingless individuals) has not long since taken the place through natural selection of the production of winged males and females. But the wingless individuals would of course have to pair always with their near relatives, whilst by the swarming of the winged Termites a chance is given to them for the intercrossing of individuals not nearly related.

From Termites I have lately turned my attention to a still more interesting group of social insects, viz., our stingless honey-bees (Melipona and Trigona). Though a high authority in this matter, Mr. Frederick Smith, has lately affirmed that "we have now acquired almost a complete history of their economy," I still believe that almost all remains to be done in this respect. I think that even their affinities are not yet well established, and that they are by no means intermediate between hive- and humble-bees, nor so nearly allied to them as is now generally admitted. Wasps and hive-bees have no doubt independently acquired their social habits, as well as the habit of constructing combs of hexagonal cells, and so, I think, has Melipona. The genera Apis and Melipona may even have separated from a common progenitor, before wax was used in the construction of the cells; for in hive-bees, as is well known, wax is secreted on the ventral side: in Melipona on the contrary, as I have seen, on the dorsal side of the abdomen; now it is not probable that the secretion of wax, when once established, should have migrated from the ventral to the dorsal side, or *vice versâ*.

The queen of the hive-bee fixes her eggs on the bottom of the empty cells; the larvæ are fed by the laborers at first with semi-digested food, and afterwards with a mixture of pollen and honey, and only when the larvæ are full grown, the cells are closed. The Meliponæ and Trigonæ, on the contrary, fill the cells with semi-digested food before the eggs are laid, and they shut the cells immediately after the queen has dropped an egg on the food. With hive-bees the royal cells, in which the future queens have to be raised, differ in their direction from the other cells; this is not the case with Melipona and Trigona, where all the cells are vertical, with their orifices turned upward, forming horizontal (or rarely spirally ascending) combs. You know that honey is stored by our stingless bees in large, oval, irregularly clustered cells; and thus there are many more or less important differences in the structure, as well as in the economy, of Apis and Melipona.

My brother, who is now examining carefully the external structure of our species, is surprised at the amount of variability which the several species show in the structure of their hind legs, of their wings, etc., and not less are the differences they exhibit in their habits.

I have hitherto observed here fourteen species of Melipona and Trigona, the smallest of them scarcely exceeding two millimetres in length, the largest being about the size of the hive-bee. One of these species lives as a parasite within the nests of some other species. I have now, in my garden, hives of four of our species, in which I have observed the construction of the combs, the laying of the eggs, etc., and I hope I shall soon be able to obtain hives of some more species. Some of our species are so elegant and beautiful and so extremely interesting, that they would be a most precious acquisition for zoological gardens or large hot-houses; nor do I think that it would be very difficult to bring them to Europe and there to preserve them in a living state.

If it be of some interest to you I shall be glad to give you from time to time an account of what I may observe in my Melipona apiary. — *Nature.*

THE EUROPEAN HOUSE SPARROW. — I regret very much that a naturalist generally so well informed as Dr. Coues, should aid in giving what my own observations compel me to believe to be an altogether wrong statement in regard to the house sparrow, published in the July number of the NATURALIST. Dr. Coues admits that he was prejudiced against the sparrow from the beginning. He expected they would molest our native species; he was always opposed to their introduction, and he is now apparently only too glad to condemn them on the scantiest evidence. I submit that this is too important a question to be thus dismissed, especially by a gentleman like Dr. Coues, who has enjoyed no opportunity of knowing from his own observations whether the opinions he is so free to express are well founded or not.

The statement of Mr. Gentry I entirely discredit. I do not believe that the habits either of the house sparrow or of the robin, blue-bird and our native sparrows are different in Pennsylvania, from what they are in Massachusetts. I believe that if any evil has befallen these birds in Pennsylvania, Mr. Gentry does not assign the right cause and that the house sparrow is innocent. We have the sparrows in Boston in great abundance, and for six years I have day after day, summer and winter, closely watched them. They never molest, attack, or try to drive away any birds, except their own species, and that only from amatory influences. In such times the males are pugnacious against other males of their own species, but nothing more.

The females are not at all pugnacious under any circumstances. In Boston the robin has never been so abundant as it is this summer, and the sparrows certainly never seem so numerous.

They feed together, side by side, and the only molestation the robin experiences is that once in a while a sparrow steals the worm it has dragged from the ground. But the sparrow has to do this slyly, and to drive off a robin would be an undertaking simply absurd.

Then as to the native sparrows. If any one of these seems exposed to being driven off it would be our little amiable chipping sparrow. Before we had their European cousins this bird was hardly known as a visitant to our city. Now they have become abundant, in their season, and what is very remarkable, they seek out and keep company with the European. Any day you please, in summer, you may see the house sparrow and the chipping sparrow feeding together in close proximity and you will never see the former molest or interfere with his confiding companion.

As for the blue-birds, the boot is on the other leg. The blue-birds do molest and drive off the sparrow, and have been known to take possession of and keep boxes put up for and belonging to the sparrow. My friend, John R. Poor, Esq., of Somerville, had succeeded in introducing the house sparrow into his grounds, in the early spring of 1871. They had begun to build in the boxes put up for their homes, when blue-birds appeared and drove them off, and made use of their boxes!

As for the opinion expressed by Dr. Coues that the sparrow is not needed here, that the good they do is overrated, etc., I will not trespass upon your space now by seeking to controvert an opinion so utterly confronted by overwhelming evidence all around us. I will only refer him to the report of the French parliament based upon the most thorough investigations of Prévost, placing the sparrow at the head of the useful birds of France; to the testimony of George N. Lawrence as to their destruction of the measure-worm in New York, Brooklyn, Newark, etc., and to our own city forester of Boston, who can inform him, if he discredits my testimony, how the sparrows here did what man was unable to do in arresting the ravages of the *Orgyia leucostigma*.—THOMAS M. BREWER.

FISH CULTURE IN THE OLDEN TIME. — Most of the popular accounts of artificial fish breeding, and the artificial stocking of rivers with fish, state that this is a very new thing. May I call the attention of the readers of the NATURALIST to the following extract from Kalm's Travels. It will be remembered that at the suggestion of Linnæus, Peter Kalm was sent to North America "to make such observations and collect such seeds and plants as would improve the Swedish husbandry, gardening, manufactures, arts and sciences." He arrived at Philadelphia in Sept., 1748, and left the country early in 1751. He recorded his observations on nearly every conceivable subject, from "the way of eating oysters" and the "art of making apple dumplings" to the most interesting observations on society, politics, agriculture and natural phenomena and productions. The expenses of his trip were paid in part by the government of Sweden, in part by the University of Upsala, by societies and private subscription, Kalm himself contributing to the extent of his ability, "so that at his return he found himself obliged to live upon a very small pittance." I quote from the English translation of his travels, published in London in 1772. After speaking of the diminution of fish in various rivers, caused by "immoderate catching of them at all times of the year" and "the numerous mills on the rivers and brooks" whose dams prevent the fish from passing "up the river in order to spawn," he says (Vol. 1, p. 229):

"Mr. FRANKLIN told me, that in that part of *New England* where his father lived, two rivers fell into the sea, in one of which they caught great numbers of herrings, and in the other not one. Yet the places where these rivers discharged themselves into the sea were not far asunder. They had observed that when the herrings came in spring to deposit their spawn, they always swam up the river where they used to catch them, but never came into the other. This circumstance led *Mr. Franklin's* father, who was settled between the two rivers, to try whether it was not possible to make the herrings likewise live in the other river. For that purpose he put out his nets, as they were coming up for spawning, and he caught some. He took the spawn out of them and carefully carried it across the land into the other river. It was hatched and the consequence was that every year afterwards they caught more herrings in that river; and this is still the case. This leads one to believe that the fish always like to spawn in the same place where they were hatched, and from whence they first put out to sea; being, as it were, accustomed to it."

He had already said (p. 23) that "*Mr. Benjamin Franklin*, to whom *Pennsylvania* is indebted for its welfare, and the learned world for many new discoveries in electricity, was the first who took notice of me, and introduced me to many of his friends.

He gave me all necessary instructions and shewed me his kindness on many occasions." Here is another item that is of interest. While speaking of New York, and the oysters found there, he goes on (I, p. 187),—"LOBSTERS are likewise plentifully caught hereabouts, pickled much in the same way as oysters, and sent to several places. I was told of a remarkable circumstance about these lobsters, and I have afterwards frequently heard it mentioned. The coast of *New York* had already *European* inhabitants for a considerable time, yet no lobsters were to be met with on that coast; and though the people fished ever so often, they could never find any signs of lobsters being in this part of the sea; they were, therefore, continually brought in great well-boats from *New England*, where they are plentiful; but it happened that one of these well-boats broke in pieces at *Hellgate*, about ten *English* miles from *New York*, and all the lobsters in it got off. Since that time they have so multiplied in this part of the sea, that they are now caught in the greatest abundance."—WM. H. BREWER.

THE INFLUENCE OF THE NERVES UPON THE CHANGE OF COLOR OF FISH AND CRUSTACEA.—A change of color is observed in many fish. It may be rapid and intense, as in the chameleon, but lacking its variety. Pouchet studied this phenomenon in a fish-breeding pond in Concarneau, among species of Blennius, Gobius and Pleuronectidæ. In a former communication to the Academy of Science, Pouchet reported that this change of color of the surface of the fish, corresponding to the color of its surroundings, originated in the brain, and the impression was caused by the action of the surrounding medium upon the retina. With the extirpation of the eyes this power of the animal disappeared. The blinded pleuronectide receives a subdued tint which remains, whatever be the color of the surroundings. This neutral coloring seen upon the entire body may be called a paralysis of the pigment cells. Pouchet tried to prove the influence of the nerves upon the pigment cells in the following experimental manner. Young Pleuronectidæ that changed their color with rapidity were kept in a tank with a brown bottom; before severing the nerve they were put into another tank, the bottom of which was covered with sand; here the specimens operated upon became bleached. Except those portions especially influenced by the nerves, they retained their dark color. By separating the spinal cord no such result was observed. When the trigeminal nerve was severed, all of the pigment cells on that side of the head supplied by it were paralyzed. The animal operated upon, kept in a tank with a sandy bottom, had a faded color, only a small portion of the head remained dark, a smaller or larger portion, depending upon how large a part of the trigemimus was severed. A corresponding result followed the separation of the spinal nerves. The course of the severed nerve was followed by a dark colored stripe; on the back of the pleuronectide, zebra-like lines were seen. The resultless severing of the spinal cord proves, that the influence that a spinal nerve has upon the coloring cells does not proceed from the spinal cord. The splanchnic and sympathetic nerves are then brought into question. The severing of the former gives no result. If on the contrary the sympathetic nerve is severed anywhere on the inferior portion of the vertebral canal, paralysis of all of the pigment cells of the skin occurs, posterior to the cut. The deep position of the fine delicate sympathetic nerve makes it impossible to divide without injuring the neighboring parts. The animal survives the operation two and three days. During this time it is half light and half dark colored. Similar trials made upon the infra-maxillary nerve and artery, both of which lie superficially and are accessible, make it possible that the real nerve stem which regulates the movement of the pigment cells is not the one that accompanies the blood-vessel. Pouchet tried cutting the sympathetic nerve at its origin, behind the articulation of the suspensorium, but with such result as was anticipated. The length of time that the paralysis of the pigment cells lasts, after the nerve is severed, is not fully known; it has been found to remain some weeks as marked as at first. The paralyzed portions upon the surface of the body receive this mixed color, like the blind pleuronectidæ now dark, now light, according as the remaining portion of the skin is influenced by the surroundings. Poisoning the fish with curare, strychnine, morphine, veratria and sontonin has no especial influence upon the change of color.

The influence of habit was marked. A pleuronectide, that had lived a long time in a tank, the bottom of which was covered with sand, when removed to one with a brown bottom, remained four days before it fully received a corresponding color.

Pouchet noted his observations daily, and came to the conclusion that the change of color is at times influenced, but that the origin of the same, is not yet well understood. At certain hours during the day, when it is cloudy for instance, those spots in the operated animals which were in a paralyzed state were scarcely to be perceived, and again in an hour or so later, they stood out in a very marked contrast, in color, to the rest of the skin, without the foundation color having changed.

The power of bringing the color into harmony with the surrounding medium among the crustacea, was remarkably shown in the *Palæmon serratus*. Animals from three to four centimetres long are the best to experiment upon, placed in porcelain vessels with black or white bottoms. The crabs that fishermen bring ashore have a rose or a dark lily color; if they are put into vessels with black or white bottoms in twenty-four hours, they will assume a color wholly unlike each other. Those in the white dish are yellowish, almost colorless, as if they had just shed their skin, and those in the dark colored dish are of a brown red color. When changed the pale one into the dark colored dish, and *vice versâ*, they change color in a corresponding manner. The change of a pale one to a dark color, was more rapid than the reverse. Under favorable conditions we can create a yellow, red and blue Palæmon. If a foot is removed when any one of these colors is present, and put into a solution of sugar, the three colors appear successively before the eye. The microscope reveals the sequel to this. If the pigment cells are pressed together like balls, then they are too minute to mirror themselves upon the retina. As soon as the animal is placed upon a dark ground the coloring cells are distended and send out little branches on all sides; then they become perceptible to the eye. The animal becomes red rose colored, when nothing weakens the lively color of the pigment cells; as the branches of the latter distend under the hypodermis they receive a cobalt color and the carmine of the pigment cells becomes thereby browned, and thus the Palæmon takes on a color corresponding to the foundation. If the coloring cells contract again, the blue remains six or seven hours in the hypodermis and then gradually disappears. With the Palæmon as with fish, the change of color is the result of visual impressions.

Among animals whose eyes Pouchet extirpated, a continuous dark color was observed and continued during the entire time, thirty-four days. By severing the nerves, an explanation of the phenomena was not attained.

Pouchet adds in conclusion, that in the eyeless crustacea, the pigment cells are wanting.—(*Translated* by Dr. Mary J. S. Blake *from Schmidt's Jahrbücher, No.* 9, 1872).

The Cotton Worm.—I have already shown that this insect is first described and named scientifically by Hübner in 1822, as *Aletia argillacea* from Brazil. It is an inhabitant of more southern latitudes than the cotton belt of the Southern States. I have shown that the insect is found during the winter as a moth, not from "analogy," but fact. I have also shown that the insect dies out in the central and northern portions of the cotton belt every year, and is replaced the succeeding year by immigration from more southern localities, and where the cotton plant is perennial. Prof. Glover's observations on the moth seem to me to be generally correct and reliable; on the other hand, Prof. Riley's remarks in the Sixth Missouri Report are, where Prof. Glover is contradicted, a "too hasty generalizing," and show nowhere any original acquaintance with the subject. The moths have been collected by Prof. Packard on an island in Salem harbor, Mass.; and by Mr. Burgess in Massachusetts Bay, flying over the water, and by myself about Buffalo, N. Y. The worm never attacks the young cotton in Central Alabama in the spring or early summer, but appears at its earliest at the end of June, and is invariably preceded by flights of the adult moth. Since in Central Alabama insect life begins as early as March (and before then the "hybernated" cotton moth has disappeared) what is the *Aletia argillacea* doing between that date and July, when the worm appears? And why is the young cotton not attacked in May by the worms from the eggs deposited by the "hybernating" moths? If the "hybernating" moths lay eggs, their progeny perish from lack of food. But many chrysalides are killed by frost, and there is great irregularity about the completion of the final brood, of moths arising from the age of the insect and the approach of the winter.—A. R. Grote.

Larvæ of Anopthalmus and Adelops.—The larvæ and pupa of Anopthalmus, from Salt cave near Mammoth, were discovered in May last by Mr Sanborn and myself while engaged in exploring the caves of Kentucky under the auspices of the Geological Survey of Kentucky. The larvæ of Anopthalmus were found running under stones on the sand in damp situations in company with the beetles, while the pupæ were found lying in little oval holes in the same situation and at the same date. The larva is more closely allied to that of *Pterostichus nigrita*, figured by Schiödte, than any I have seen figured. The body, however, is rather slenderer, the head much longer and narrower, and the mouth parts longer, while the caudal appendages are shorter. The end of the body is like that of Harpalus and Stenolophus as figured by Schiödte, but the form of the mandibles is more like that of Harpalus. There are no eyes, and the body is white and soft, not chitinous as in Carabid larvæ generally. There is no sculpturing on the head or thoracic segments.

The larvæ of *Adelops hirtus* has a body somewhat like that of Agathidium, but the head is very much larger and as wide and long as the prothoracic segments. It is white, and I can perceive no eyes. The body tapers rapidly from the prothorax to the end, and is provided with long hairs. The antennæ are large and long. The larvæ of these beetles have not yet been discovered in Europe. —A. S. PACKARD, JR.

NEW VARIETY OF BLUE GROSBEAK.—Several Mexican examples of *G. cœrulea* examined, uniformly differ from the United States bird in the following particulars: they are larger; wing 3·70 instead of 3·40, tail 3·00, as against 2·70; total length about 7·00. The bill, in particular, is notably larger every way, and especially deeper, with a more swollen upper mandible and more curved ridge. Length of culmen 0·70, extreme depth about the same; in *G. cœrulea*, culmen 0·60, depth decidedly less. It is mostly light brownish horn-color, instead of mostly blackish. I see no difference in the plumage. This appears to be the resident Mexican form, and to be quite as "good" a variety as many of those now current. It may be termed *G. cœrulea* var. *eurhyncha*.—ELLIOTT COUES.

DIMORPHISM IN GALL FLIES.—Mr. H. F. Bassett (Canadian Entomologist, v, 91) states that *Cynips q. operator* is double brooded; thirty of one brood of females ovipositing in the buds of the oak, and again some of a second brood ovipositing in the young acorns of *Quercus ilicifolia*. From these and other facts he infers " that all our species that are found only in the female sex are represented in another generation by both sexes, and that the two broods are, owing to seasonal differences, produced from galls that are entirely distinct from each other." This confirms Walsh's discovery of dimorphism in the Cynips (see Amer. Ent. ii, p. 320).

SWEET SCENTED ANTS.*—I have just returned from Mr. A. J. Lauderdale's, where I had been on a visit of inquiry in reference to the sweet ants. The whole family were present, and all declare that they have often smelt them, when by accident, in their nocturnal visits, one would get crushed under foot. They have also captured them and smelt their sweet perfume when crushed between the fingers. Capt. Lauderdale states that the odor which the ants emitted on being crushed surpassed in sweetness any perfumery he had ever seen; that he had repeatedly searched for them since he evacuated the place, without success; that the horticultural ants had, since the house was left unoccupied, filled up the fireplace with bushels of sand; and gave it as his opinion that they had driven off the fragrant ants. My son examined them and pronounced it the sweetest odor he had ever experienced.

These ants are extremely rare, but that they do exist there is but little doubt.—GIDEON LINCECUM, *Long Point, Texas.*

ROBBER ANTS.*—Once upon a time there dwelt in my yard a flourishing colony of the very smallest species of black ant. The servants about my cook house had spilt a quantity of syrup which run through the floor. The little ants had found it, and seemingly the entire population were out and busy packing it away to their home.

The microscope showed that they carried the syrup in their abdomen. But before they had secured all the syrup, I observed there was great excitement along their road. The larger, black, erratic ants had discovered them while carrying home the syrup, and were taking it away from them. It was really painful to observe the ruthless manner in which they slaughtered and robbed the helpless little ants of their distended sacks of sweetness.

They grabbed up the heavily burdened little fellows, doubled them, and, biting open the abdomen, drew out the full sack and seemed to swallow it; then, casting the lacerated carcass aside, they furiously sprang upon another of the panic-stricken crowd and repeated the horrid operation. Millions of these heartless butchers were at work; and soon, *on account of their wealth*, that populous city was exterminated.—G. LINCECUM.

ICHNEUMON PARASITES OF ANTHRENUS LARVÆ.—We have received from Mr. E. S. Cassino two small ichneumon larvæ found on July 30th in that of the Anthrenus. We are not aware that this destructive museum pest is known to be thus affected.

---

* Communicated in a letter to the Smithsonian Institution, and published by permission of Professor Henry.

LARVÆ OF MEMBRACIS SERVING AS MILK CATTLE TO A BEE.—Fritz Müller has observed in Brazil a larva of a leaf-hopper (*Umbonia indicator* Fairm.) which is used, like the Aphides by the ants, as milch cattle by a species of stingless bee (*Trigona cagafogo* Müll.) This bee is fond of oily matters, and feeds on carrion, old stinking cheese and oil secreted by various plants. Although stingless, it possesses a very intense venom, which causes a most lively irritation in the skin.

ANTHROPOLOGY.

A TRUE GEOGRAPHY OF THE BRAIN.—It has until lately been supposed that the convolutions of the cerebrum are entirely concerned in purely intellectual operations, but this idea is now at an end. It is now evident, from recent researches, that in the cerebral convolutions—that is, in the part of the brain which was believed to minister to intellectual manifestations—there are nerve-centres for the production of voluntary muscular movements in various parts of the body. It has always been taught that the convolutions of the brain, unlike nerves in general, cannot be stimulated by means of electricity. This, although true as regards the brains of pigeons, fowls, and perhaps other birds, has been shown by Fritsch and Hitzig to be untrue as regards mammals. These observers removed the upper portion of the skull in the dog, and stimulated small portions of the exposed surface of the cerebrum by means of weak galvanic currents, and they found that when they stimulated certain definite portions of the surface of the convolutions in the anterior part of the cerebrum, movements are produced in certain definite groups of muscles on the opposite side of the body. By this new method of exploring the functions of the convolutions of the brain, these investigators showed that in certain cerebral convolutions, there are centres for the nerves presiding over the muscles of the neck, the extensor and adductor muscles of the forearm, for the flexor and rotator muscles of the arm, the muscles of the foot, and those of the face. They, moreover, removed the portion of the convolution on the left side of the cerebrum, which they had ascertained to be the centre for the movements of the right forelimb, and they found that after the injury thus inflicted, the animal had only an imperfect control over the movements of the part of the limb in question. Recently Dr. Hughlings Jackson, from the observation of various diseased conditions in which peculiar movements occur in distinct groups of muscles, has adduced evidence in support of the conclusion that in the cerebral convolutions are localized the centres for the production of various muscular movements. Within the last few months these observations have been greatly extended by the elaborate experiments of my able colleague in King's College, Prof. Ferrier.

Adopting the method of Fritsch and Hitzig—but instead of using galvanic he has employed Faradic electricity, with which, strange to say, the investigators just mentioned obtained no very definite results—he has explored the brain in the fish, frog, dog, cat, rabbit and guinea-pig, and lately in the monkey. The results of this investigation are of great importance. He has explored the convolutions of the cerebrum far more fully than the German experimenters, and has investigated the cerebellum, corpora quadrigemina, and several other portions of the brain not touched upon by them. There is, perhaps, no part of the brain whose function has been more obscure than the cerebellum. Dr. Ferrier has discovered that this ganglion is a great centre for the movements of the muscles of the eyeballs. He has also very carefully mapped out in the dog, cat, etc., the various centres in the convolutions of the cerebrum, which are concerned in the productions of movements in the muscles of the eyelids, face, mouth, tongue, ear, neck, fore and hind feet, and tail. He confirms the doctrine that the corpus striatum is concerned in motion, while the optic thalamus is probably concerned in sensation, as are also the hippocampus major and its neighboring convolutions. He has also found that in the case of the higher brain of the monkey there is what is not found in the dog or cat—to wit, a portion in the front part of the brain, whose stimulation produces no muscular movement. What may be the function of this part, whether or not it specially ministers to intellectual operations, remains to be seen. These researches of Fritsch, Hitzig, Jackson, and Ferrier, mark the commencement of a new era in our knowledge of brain function. Of all the studies in comparative physiology there will be none more interesting, and few so important, as those in which the various centres will be mapped out in the brains throughout the vertebrate series. A new, but this time a true, system of phrenology will be founded upon them; by this, however, I do not mean that it will be possible to tell a man's faculties by the configuration of his skull, but that the various mental faculties will be assigned to definite territories of the brain, as Gall and Spurzheim long ago maintained, although their geography of the brain was erroneous.—Prof. RUTHERFORD *in Nature.*

Dr. Brown Sequard has called in question the conclusions given above in lectures delivered in Boston last March.

RATE OF GROWTH IN MAN.—In an interesting account of the life and works of the late Belgian anthropologist and statistician, Adolphe Quetelet, published in "La Revue Scientifique," occur the following remarks on the rate of growth in man. "The most rapid growth takes place immediately after birth; the infant in the space of a year grows about two decimetres.* The increase in size diminishes gradually as its age increases, up towards the age of four or five years; when about three it attains half the size which it is to become when full-grown. When from four to five years of age the increase in size is very regular each year up to sixteen years, that is to say up to the age of puberty; this annual increase is nearly fifty-six millimetres. After the age of puberty the size continues to increase, but feebly; when from sixteen to seventeen years old the individual increases four centimetres (·60 inch). In the two years following, it increases only one inch. The total increase in size of man does not appear to be entirely terminated when he is twenty-five years old. The mean size is a little larger in cities than in the country."

MICROSCOPY.

NEW ROTATING MICROSCOPE.—Mr. Browning has introduced into England the continental fashion of attaching the bar of the microscope to the stage which is made to revolve carrying the body with it. This, of course, gives a rotating stage without any difficulty in regard to centring. Any tremor, also, connected with the revolving apparatus is common to the object and the magnifying apparatus, and is therefore of little consequence. For objects illuminated from below, this arrangement is practically as good as the more difficult and expensive plan of rotating the stage only; though for objects illuminated from above it is less convenient. It is also made binocular.

---

*A decimetre is one-tenth of a metre, amounting to nearly four inches.

Mounting Diatoms.—It is due to Dr. Christopher Johnston of Baltimore, to say that I am indebted to his very valuable paper, on the "Preparation of Diatomaceæ" for the method of retaining the diatoms in place, mentioned in my note. If dry mounting is preferred, I have found by experiment, that the diatoms may be arranged as before stated on the cover, without the gelatine coat, and fixed in place by moistening with vapor as before stated. This plan has some advantages for real study.—W. W. Riner.

Blood Crystals.—The detection of blood by finding its crystals is a much easier process than has been thought, and is also much more generally applicable. In blood decomposed, or that has been treated by acids or caustic alkali, hæmoglobin is changed into a new substance; hæmatin is formed, which, combined with hydrochloric acid, gives characteristic crystals. In order to obtain them we must proceed thus: A small fragment of dried blood is placed on a slide; it is dissolved in a drop of water, and a minute portion of sea-salt is added. It is covered with a thin slide, and pure acetic acid is made to pass between the two slides, and it is heated over a spirit-lamp to boiling point. Acetic acid is again added, and it is heated afresh; this is repeated till the crystals are obtained. They are rhomboidal, of a dirty brown color, quite characteristic, and require to be seen with a magnifying power of three hundred or four hundred diameters. With the smallest quantity of blood this reaction can always be produced.—*Popular Science Review.*

Tolles' new immersion ⅙th.—About three weeks since I received from Mr. R. B. Tolles a ⅙th immersion objective, similar to the one purchased by Mr. Crisp of London (see M. M. J. for March 1874). Mr. Tolles claims for this objective an angle of 180° in air and about 100° in balsam. Simple appliances at my command demonstrate I think conclusively that this glass will receive and convey to the eye "image-forming rays" incident to the front surface of front lens at an angle of 10° = aperture of 160. The performances of this new ⅙th are at once novel and remarkable, on *Amphipleura pellucida* (dry) it shows the transverse striæ with singular beauty. The "lines" appearing to shine with golden lustre. Specimens of *Frustulia saxonica* (very small) that have persistently defeated a fine modern $\frac{1}{16}$th in my possession, my Tolles wet $\frac{1}{10}$, as also a $\frac{1}{15}$th belonging to a friend, surrender at once to this $\frac{1}{6}$th giving strong transverse striæ. The markings of *Surriella gemma* (dry mounted) are shown very strongly. Either as dots or hexagons, mounted in balsam the markings are much stronger than I have before seen with any lens. The behavior of this $\frac{1}{6}$th over *Cymatopleura elliptica* excited my unqualified admiration. In short "this most interesting glass," goes satisfactorily through my collection of test diatoms. The illumination used was (for the most part) from a German student's lamp. The maximum performance of the $\frac{1}{6}$th is obtained by working through a thick cover, say $\frac{1}{75}$th of an inch; with such a cover the objective works well dry, using central or nearly central light. Perhaps the most valuable property of the new $\frac{1}{6}$th will be recognized in its superior performances by centrally disposed light. With the experience I have had of the $\frac{1}{6}$th in this direction I am forced to the conclusion that these new system glasses of Mr. Tolles will become equally valuable to histologists and diatomists.—J. EDWARDS SMITH, *Ashtabula, O., July*, 1874.

NOTES.

THE HARTFORD MEETING of the American Association for the Advancement of Science was in several ways a great success. The register exhibited the names of about 225 old members who were present, and 118 new members were elected. 165 papers were entered, ten of which were not passed by the Standing Committee for the want of abstracts, and twenty others were either withdrawn by their authors or declined by the Sectional Committees, leaving sixty-six papers in Section A, and sixty-nine in Section B. Of those in Section B, ten were given by title only, and the rest were read by their authors before the section or proper subsection, and were more or less discussed. Section A formed a subsection of chemistry on Monday afternoon, which was very strongly represented and held its session until Tuesday evening. The additional interest taken by the chemists in the Hartford meeting was undoubtedly owing to the resolutions passed at Northumberland, by which they declared that it was unadvisable to form a separate society, and agreed to enter the Association and establish a permanent subsection. Their action in this respect cannot be too heartily endorsed by the scientists of the country, for it is just such action, on the part of all the different bodies of scientific men that now annually meet independent of the Association, that is needed to make the American Association the great power in this country which the British Association has become in England by the united efforts of all persons interested in the advancement of science. We feel confident that it will not be long before the Association of Mining Engineers will realize the advantages to be secured by uniting with the American Association, especially as under the new constitution they could organize, as the chemists have done, as a permanent body. The entomologists were present in goodly numbers, and while taking an active part in the meetings of Section B, they also organized as a club and held separate evening meetings, under the name of the Entomological Club of the American Association. From much that was said and done at the recent meeting, it was very evident that a strong feeling has expressed itself over all parts of the country in favor of a united effort to make the future meetings of the American Association in every way the expression of the advancement of science in the country, and with this effort, which is simply the natural result of the growth of the Association, the process of absorbing all the smaller scientific bodies of a national character is only a matter of time. The botanical element was more largely represented at the Hartford meeting than we remember ever to have noticed before, and now that the impetus has been given it is very reasonable to expect large additions from the botanical ranks at the future meetings. The geologists were as usual well represented and formed a subsection for Monday and Tuesday, with Prof. J. D. Dana in the chair. There were also more papers bearing on general zoological questions this year than for several past meetings, and Anthropology was made prominent by a number of quite interesting communications. On Monday Section B subdivided into Biology and Geology and continued to hold its meetings in subsections until Tuesday evening, when it held its final session with the exception of a very short one on Wednesday morning.

The older members were largely represented at this meeting, and a noticeable feature was the attendance of a number of past presidents of the Association. Under this head we recall Prof.

W. B. Rogers who ranks as the first president, he being in office when the Association was formed by the enlargement of the older Association of Geologists and Naturalists. The presence of Prof. Rogers was greeted with joy, as his health has prevented his taking his former active part in the meetings for several years. Professors Joseph Henry, J. D. Dana, F. A. P. Barnard, B. A. Gould, T. Sterry Hunt, Asa Gray, J. Lawrence Smith, and the retiring president, Prof. Joseph Lovering, were also present.

The address of the retiring President gave universal satisfaction, and though bearing more on the section to which he specially belongs than to Section B, we feel that all our readers will be glad to have us follow our course for several years and present it to them in the following numbers of the NATURALIST.

The social element of the meeting was well developed, and though there was very little private entertainment given to the members by the residents, there was a large number of citizens who, as the Local Committee, took an active interest in the Association, and in many ways made the meeting a very pleasant one. The only levee given to the Association was by Dr. Stearns on Thursday when a very enjoyable evening was passed. Several special invitations were received from the managers of the various institutions and large establishments in and about Hartford, and most of them were very generally accepted by members, and many very interesting works were visited. The special excursions arranged by the Local Committee were well planned and admirably carried out. The steamer excursion down the Connecticut to its mouth and return, on Saturday, was a perfect one and was greatly enjoyed by the several hundred persons who passed the day on the river; while the geologists, and all others who wished to go, had their full share in the several afternoon excursions to Tariffville and the Portland quarries; and all who went on the afternoon excursion to Cheneyville could only have experienced great pleasure at the sight of this model and beautiful little village, where the silkworm's slender threads are unwound and woven into substantial fabrics and gay ribbons. On Thursday, the day following the adjournment, a very interesting excursion took place, and consisted of a trip through the most beautiful portion of the State to Lakeville and the iron mines of Salisbury.

As was expected, a large amount of time was occupied in discussions relating to the new constitution, but as this very important matter was finally settled to the perfect satisfaction of all concerned, it was time well spent, and it is now believed that the future of the Association is firmly established on a basis that is fully adapted to the work it is to perform. The acceptance of the Act of Incorporation also gives an important legal existence to the Association which will add greatly to its power. The officers for the next meeting were elected under the new constitution, and very great additions to the interest and importance of the future meetings are expected from the addresses of the Vice-Presidents and the Permanent Chairmen of subsections. An important addition to the Standing Committee is also secured by the new constitution, as under it the past Presidents are now life members of the Committee; and the Secretaries, as well as the Chairmen of the sections, will be members of the Committee. In this way, the Committee becomes a much larger body, consisting of the veterans of American Science as well as the active officers of the Association, and will be fully capable of performing the important work that devolves upon it. It is also believed that by the election of the Secretaries of the sections a year in advance they will fully realize the importance of the position and the responsibilities which they accept.

The very cordial invitation which came from Detroit for the Association to hold its next meeting in that city, was so warmly tendered by the Governor of the State, the Mayor of the city, and the Detroit Scientific Society, that it was impossible for the Association to do anything but accept, and it was unanimously voted to hold the next meeting in Detroit, beginning on the second Wednesday in August, 1875.

The following were elected as the officers for the next meeting: *President*, J. E. Hilgard, of Washington; *Vice President of Section A*, H. A. Newton, of New Haven; *Vice President of Section B*, J. W. Dawson, of Montreal; *Chairman of Chemical Subsection*, S. W. Johnson, of New Haven: *Permanent Secretary for five years*, F. W. Putnam, of Salem; *General Secretary*, Samuel H. Scudder, of Boston; *Treasurer*, W. S. Vaux, of Philadelphia; *Secretary of Section A*, S. P. Langley, of Allegheny, Pa.; *Secretary of Section B*, N. S. Shaler, of Newport, Ky.

The officers of Section B, Natural History, for the Hartford meeting were:—*Permanent Chairman*, Mr. S. H. Scudder, of Cambridge; *Secretary*, Prof. Theo. Gill, of Washington; *Sectional*

Committee, Prof. S. F. Baird, of Washington; Prof. E. T. Cox, of Indianapolis; Prof. T. Sterry Hunt, of Boston.

Subsection of Biology. *Chairman*, Rev. Dr. E. A. Dalrymple, of Baltimore; *Secretary*, Mr. W. W. Bailey, of Providence. Subsection of Geology. *Chairman*, Prof. James D. Dana, of New Haven; *Secretary*, Prof. E. W. Hilgard, of Ann Arbor.

The following is a list of the papers read in Section B:—

The Genera of Butterflies studied historically, by Samuel H. Scudder.
Discovery of twelve skeletons of *Dicotyles compressus* in the Valley Drift in Columbus Ohio, by John H. Klippart.
Present distribution of woodlands within the United States, by William H. Brewer.
Further Contributions to Physiographic Geology, by Richard Owen.
Change by Gradual Modification not the Universal Law, by Thomas Meehan.
On the Cotton Worm (*Aletia argillacea* Hübn), by Aug. R. Grote.
On *Sarracenia variolaris* as a Fly Catcher, by Dr. J. H. Mellichamp.
Darlingtonia Californica, an Insectivorus Plant, by Wm. H. Canby.
The Lobster, by W. W. Wheildon.
On the Insects more particularly associated with *Sarracenia variolaris* (Spotted Trumpet leaf), by C. V. Riley.
On the Summer Dormancy of the Larvæ of *Phyciodes nycteis* Doubleday, with Remarks on the Natural History of the Species, by C. V. Riley.
Further observations on the Geology of Northwestern Massachusetts, with special reference to the Hoosac range, by Sanborn Tenney.
Botanical Observations, by Wm. H. Seaman.
Glacial Phenomenon in the Sierra Nevada, by John Muir.
Cremation among North American Indians, by John L. LeConte.
Instance of Replacement of Injurious insects by Human agency, by J. L. LeConte.
Geological Map of the United States and Territories, with Critical and Explanatory descriptions, by Prof. C. H. Hitchcock and Wm. P. Blake.
On Regeneration or Organic Molecular Conservation: a contribution to the doctrine of evolution, by Louis Elsberg.
On the Habits and Transformations of *Canthon Hudsonius* (Forst,) the common "Tumble-dung," by Charles V. Riley.
On the Larval Habits of the Cantharid genera *Epicauta* and *Henous*, by C. V. Riley.
On the Origin of North American Unionidæ, by Edward S. Morse.
On the Relations of Dentalium, by E. S. Morse.
On the Cave Fauna of the Middle States, by A. S. Packard, Jr.
Remarks on the Anderson School of Natural History, by F. W. Putnam.
On the Male and Female organs of the Sharks, with special reference to the use of the "Claspers," by F. W. Putnam and S. W. Garman.
On the Composition of the Pottery of the Mound-builders, by E. T. Cox.
A Remarkable Ancient Stone Fortification in Clarke County, Ind., by E. T. Cox.
Progress of Science in Maryland, by Mrs. Almira Lincoln Phelps.
Correction of previous description of the net of Hyptiotes, by Burt G. Wilder.
Note on the gestation of the little Brown Bat, by B. G. Wilder.
The relations of Amphioxus to the Marsipobranchs especially as indicated chiefly by a diagrammatic view of their respiratory apparatus, by B. G. Wilder.
The relations of the Vertebrate Classes as indicated by a tabular arrangement of their characters, constant, peculiar, and more or less common, by B. G. Wilder.
Physical History of New Hampshire, by C. H. Hitchcock.
The morphological significance and toxonomic value of the rectal pouch of Selachians (Elasmobranchs), by B. G. Wilder.
On the Significance of Classes among Vertebrates, by Theo. Gill.

On the Characters and Relations of the American Genera of Cervidæ, by Theo. Gill.
On the Relations of Certain Genera of Cervidæ, by Theo. Gill.
List of the Vertebrate Animals of Outagamie Co. Wis. with notes, by D. S. Jordan.
Remains of an ancient earth work in Marblehead, Massachusetts. by J. J. H. Gregory.
Examination of forty-five Indian graves found in Marblehead, by J. J. H. Gregory.
Notes on some rare and interesting Carices of New York, by Geo. Vasey.
On the ascending process of the Astragalus in Birds, by Edward S. Morse.
Organ of Special Sense in the Lamellibranchiate genus Yoldia, by Wm. A. Brooks.
Notes on Tree Growth. by Asa Gray.
On the Disintegration of Rocks and its Geological Significance. by T. S. Hunt.
Equivalency of the Coal Measures of the United States and Europe, by C. A. White.
The Physical and Geological Characteristics of the Great Dismal Swamp and the Eastern Counties of Virginia, by N. B. Webster.
On the True Character of the so-called Eozoon Canadense, by L. S. Burbank.
Notes on Natural Erosion by Sand in the Western territories. by G. K. Gilbert.
The Recency of certain Volcanoes of the Western U. S., by G. K. Gilbert.
The Colorado Plateau Region as a field for geological studies, by G. K. Gilbert.
Small size of the brain in Tertiary Mammals, by O. C. Marsh.
Ancient Lake Basins of the Rocky Mountains, by O. C. Marsh.
The Wings of Pterodactyls, by O. C. Marsh.
On the Mechanical Condition of the Pebbles in the Newport Conglomerate and their supposed flattening by pressure, by Wm. B. Rogers.
On the Thickness of the Virginia Tertiary, as indicated by the Artesian borings at Fortress Monroe, by Wm. B. Rogers.
Notes on the Palæozoic Formations of South America, by O. A. Derby.
On the Classification of the Indian Languages of Mexico, by Porter C. Bliss.
Observations in a visit to the Cave of Cachuamilpa, Mexico, by Porter C. Bliss.
An Ascent of the Volcano of Popocatepetl in Mexico, by Porter C. Bliss.
On the Organic Change produced in the Bee by the different conditions to which it is subjected in its Larval State, by Mrs. Sophie B. Herrick.
On contact of Trap and Sandstone in the Connecticut Valley, by Wm. N. Rice.
Origin of the Cascades of the Columbia River, Oregon, by Wm. P. Blake.
How do Young Birds peck out of the Shell? by J. W. P. Jenks.
On the Trap rocks of the Connecticut Valley, by Edward S. Dana.
An Inquiry Concerning the Reversion of Thoroughbred Animals, by W. H. Brewer.
Notice of a pair of Trap-door Spiders from South America, by Chas. R. Dodge.
Traces of Ancient Civilization in Mexico, by Porter C. Bliss.
Observations on the Mesozoic of North Carolina, by W. C. Kerr.

We have already given an account of Dohrn's zoological laboratory at Naples, and referred to the Anderson School of Natural History at Penikese, and the peripatetic laboratory annually set up by Prof. Baird in connection with the United States Fish Commission. In the January number of the "Archives de Zoologie Expérimentale," etc., M. Lacaze-Duthiers gives an interesting account of the "Laboratory of Experimental Zoology" established by him in 1872 at the suggestion of M. A. du Mesnil, director of the higher education under the minister of public instruction. It was opened on the coast at Roscoff, not far from Paris, and in a region zoologically rich. The funds devoted to the purpose were very small; the laboratory is a simple house on the seaside with five chambers and a pump to feed the aquaria; but judging by the papers which have been published by Lacaze-Duthiers, Perrier and Giard, the amount of work done is greater so far as we are aware than at any other laboratory of the sort. An excellent feature of the "Laboratory of Experimental Science" is that it is not to be permanently established at one spot, but every five or six years will be moved from place to place until the marine fauna of France shall be thoroughly investigated. In this way a series of works will gradually be produced on the fauna of France.

There is still an opening in this country for just such schools as this, which combining general education and special research shall, in an inexpensive way, hold sessions of say, two months, extending over a few years at a time at different points along our coast. For example, the southern colleges could send professors and a few advanced students to Beaufort, N. C.; the Washington and Georgetown colleges could combine and have a summer session at Old Point Comfort; the Pennsylvania Colleges could rendezvous at Cape May, while the western and northern colleges could continue sending students to the Anderson School at Penikese. By mutual assistance and coöperation our extensive coast could be thoroughly explored and higher biological researches be carried on, as well as observations on the chemistry and physics of the sea.

THE Anderson School of Natural History at Penikese Island closed on the 29th of August. Fifty students received instruction including laboratory work and lectures from ten professors, and the degree of attention given and amount of original work done was gratifying. The moral success of the school is established, and we hope that want of means will not prevent the plans of the late Professor Agassiz from being carried out. There is great need of a physiological laboratory, a fish pond and other conveniences, which in time we hope will be supplied.

THE U. S. Engineers have a party in the field exploring the territories west of the 100th meridian, under Lt. Wheeler, U. S. A. Dr. H. C. Yarrow is the naturalist, and Prof. E. D. Cope the paleontologist of the expedition. The party started from Denver, Col., about July 20th. Collections will be made in all branches of Natural History. The expedition will return October 1st.

Dr. FERDINAND STOLICZKA, the paleontologist to the geological survey of India, died in India at Shayok, June 19th, aged thirty-six. A zoologist and geologist, his greatest work says "Nature," was his account of the fossil fauna discovered in the Cretaceous rocks of southern India.

THE number of visits paid during the year to the herbarium of the British museum for the purpose of scientific research, was 1020.

UPWARDS of 21,000 herbarium specimens have been received (chiefly presented) from all parts of the world at the herbarium of the Royal Gardens at Kew.

A NEW volume of Lacordaire's Genera of Coleoptera has lately appeared.

BOOKS RECEIVED.

Report of the Chief of Engineers for 1872-1873. With maps. pp. 1179 and 1257. 8vo.

Tables and Formulæ. Revised edition. Professional Papers, Corps of Engineers, U. S. A., No. 12. Washington, 1873. pp. 319, 8vo.

Geological Report of the Exploration of the Yellowstone and Missouri Rivers. By W. F. Raynolds and F. V. Hayden. 1859-1860. Washington, 1869. With map. pp. 183, 8vo.

Report upon the so-called Yellowstone Expedition of 1870. By Augustus C. Doane. Washington, 1873. pp. 40, 8vo.

Report upon Experiments made by W. H. Hearding upon the Compressive Power of Pine and Hemlock Timber, Feb. 6, 1871. By D. C. Houston. Washington, 1872. With map. pp. 12, 8vo.

Reconnaissance in the Ute Country, 1873. By E. H. Ruffner. Washington, 1874. With a map. pp. 101, 8vo.

Stability of Arches. By D. P. Woodbury. New York, 1858. With plates. pp. 428, 8vo.

Reconnaissance of the Yukon River, 1869. By Charles W. Raymond. Washington, 1871. With map. pp. 113, 8vo.

Exploration of the Yellowstone River by W. F. Raynolds, communicated by the Secretary of War. Washington, 1868. With map. pp. 174, 8vo.

Fabrication of Iron for Defensive Purposes. Washington, 1871. With plates. pp. 233, 4to. Supplement, 1872. With plates. pp. 51, 4to.

Iron Lock Gates, Weser River, Germany. Translation. By G. Weitzel. Washington, 1873. With plates. pp. 8, 4to.

Effects of Sea Water and Exposure upon the Iron-pile Shafts of the Brandywine-Shoal Light House. By John D. Kurtz and Micah R. Brown. Washington, 1874. With plates. pp. 13, 4to.

Potomac Aqueduct of the Alexandria Canal, 1835-1840. By William Turnbull. Washington, 1873. With plates. pp. 49, 4to.

Defenses of Washington. By J. G. Barnard. Washington, 1871. With plates. pp. 132, 4to.

Geological Exploration of the Fortieth Parallel. By Clarence King. Washington, 1870. Vol. III, with plates and atlas. pp. 647. 1871. Vol. V, with plates. pp. 525, 4to.

Use of the Barometer on Surveys and Reconnaissances. By R. S. Williamson. New York, 1868. Two parts. With plates and Appendix. pp. 248 and 155, 4to.

North Sea Canal of Holland and Improvement of Navigation from Rottendam to the Sea. By J. G. Barnard. Washington, 1872. With plates. pp. 77, 4to.

Preliminary Report.—Explorations in Nevada and Arizona. By G. M. Wheeler. Washington, 1872. With maps. pp. 96, 4to.

Removal of Blossom Rock, San Francisco Harbor. By R. S. Williamson and W. H. Heuer. Washington, 1871. With plates. pp. 40, 4to.

MAPS.—*Western Territories, etc. U. S. Military Map; New Mexico and Arizona; Texas, Kansas, etc.; Yellowstone and Missouri Rivers; Nebraska and Dakota; Indian Territory; South and Southeastern Nevada; Yellowstone Lake, etc., etc.*

The Land and Fresh-water Shells of La Salle County, Ill. By W. W. Calkins. Chicago, 1874, pp. 48, 8vo.

Annales Academici-Lugduni-Batavorum, 1868-1869. pp. 475. 1869-1870. pp. 268, 4to.

Transactions of the Zoological Society of London, 1874. Vol. VIII, Part 7. 4to.

Proceedings of the Zoological Society of London, 1873. Part III, with illustrations. pp. 625-862, 8vo.

Oversight over det Kongelige Danski Videnskabernes Selskabs Forhandlinger og dets Medlemmers Arbejder i Aaret 1873. L'Academie Royale de Copenhague, No. 2. With plates. pp. 268, 8vo.

Nomenclator Avium Neotropicalium. Phillippo Lutley Sclater et Osberto Salvin. London, 1873. pp. 171, 4to.

British Marine Algæ. By W. H. Grattann. London, W. C., 1874. Part X, illustrated. pp. 219-237, 8vo.

Annual Report of Department of Natural History. Northwestern University. By Oliver Marcy. Chicago, 1873. pp. 11, 8vo.

Report by the Curators to the Governor. University of the State of Missouri. Saint Louis, 1874. With plates. pp. 188, 8vo.

Iowa State Report on Insects. By C. E. Bessey. Des Moines, 1874. With plates. pp. 23, 8vo.

THE

AMERICAN NATURALIST.

Vol. VIII.—OCTOBER, 1874.—No. 10.

EXPERIMENTS ON THE SUPPOSED AUDITORY APPARATUS OF THE MOSQUITO.*

BY PROF. A. M. MAYER.

OHM states in his proposition that the ear experiences a simple sound only when it receives a pendulum-vibration, and that it decomposes any other periodic motion of the air into a series of pendulum-vibrations, to each of which corresponds the sensation of a simple sound. Helmholtz, fully persuaded of the truth of this proposition, and seeing its intimate connection with the theorem of Fourier, reasoned that there must be a cause for it in the very dynamic constitution of the ear; and the previous discovery by the Marquis of Corti of several thousand† rods of graded sizes in the *ductus cochlearis* indicated to Helmholtz that these were suitable bodies to effect the decomposition of a composite sonorous wave by their co-vibrating with its simple harmonic elements. This supposed function of the Corti organ gave a rational expla-

---

* Reprinted, with a few corrections by the author, from the American Journal of Science and Arts, Aug., 1874.

† "But all of the propositions on which we have based the theory of consonance and dissonance rests solely on a minute analysis of the sensations of the ear. This analysis could have been made by any cultivated ear, without the aid of theory, but the leading-thread of theory, and the employment of appropriate means of observation, have facilitated it in an extraordinary degree.

"Above all things I beg the reader to remark that the hypothesis on the co-vibration of the organs of Corti has no immediate relation with the explanation of consonance and dissonance, which rests solely on the facts of observation, on the beats of harmonics and of resultant sounds."—Helmholtz, Tonempfindungen, p. 342.

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

nation of the theorem of Ohm, and furnished "a leading thread" which conducted Helmholtz to the discoveries contained in his renowned work, "Die Lehre von den Tonempfindungen."* In this book he first gave the true explanation of timbre, and revealed the hidden cause of musical harmony, which, since the days of Pythagoras, had remained a mystery to musicians and a problem to philosophers.

It may, perhaps, never be possible to bring Helmholtz's hypothesis of the mode of audition in the higher vertebrates to the test of direct observation, from the apparent hopelessness of ever being able to experiment on the functions of the parts of the inner ear of mammalia. The cochlea, tunnelled in the hard temporal bone, is necessarily difficult to dissect, and even when a view is obtained of the organ of Corti, its parts are rarely *in situ;* and, moreover, they generally have had their natural structure altered by the acid with which the bone has been saturated to render it soft enough for dissection and for the cutting of sections for the microscope.

As we descend in the scale of development, from the higher vertebrates, we observe the parts of the outer and middle ear disappearing, while at the same time we see the inner ear gradually advancing toward the surface of the head. The external ear, the auditory canal, the tympanic membrane, and with the latter the now useless ossicles, have disappeared in the lower vertebrates, and there remains but a rudimentary labyrinth.

Although the homological connections existing between the vertebrates and articulates, even when advocated by naturalists, are certainly admitted to be imperfect, yet we can hardly suppose that the organs of hearing in the articulates will remain stationary or retrograde, but rather that the essential parts of their apparatus of audition, and especially that part which receives the aerial vibrations, will be more exposed than in higher organisms. Indeed, the very minuteness of the greater part of the articulates would indicate this, for a tympanic membrane placed in vibratory communication with a modified labyrinth, or even an auditory capsule with an outer flexible covering, would be useless to the greater number of insects for several reasons; first, such an apparatus, unless occupying a large proportion of the volume of an insect, would not present surface enough for this kind of receptor of vibrations; and secondly, all non-aquatic vertebrates have an inner ear formed so as to bring the aerial vibrations, which strike the tympanic membrane, to bear with the greatest effect on the auditory nerve filaments, and the minuteness of insects precludes this condition. Finally, the hard test, characteristic of the articulates, sets aside the idea that they receive the aerial vibrations through the covering of their bodies, like fishes, whose bodies are generally not only larger and far more yielding, but are also immersed in water which transmits vibrations with 4¼ times the velocity of the same pulses in air and with a yet greater increase in intensity. For these reasons, I imagine that those articulates which are sensitive to sound, and also emit characteristic sounds, will prove to possess receptors of vibrations external to the general surface of their bodies, and that the proportions and situation of these organs will comport with the physical conditions necessary for them to receive and transmit vibrations to the interior ganglia.

---

* According to Waldeyer, there are 6,500 inner and 4,500 outer pillars in the organ of Corti.

Naturalists, in their surmises as to the positions and forms of the organ of hearing in insects, have rarely kept in view the important consideration of those physical relations which the organ must bear to the aerial vibrations producing sound, and which we have already pointed out. The mere descriptive anatomist of former years could be satisfied with his artistic faculty for the perception of form, but the student of these days can only make progress by constantly studying the close relations which necessarily exist between the minute structure of the organs of an animal and the forces which are acting in the animal, and which traverse the medium in which the animal lives. The want of appreciation of these relations, together with the fact that many naturalists are more desirous to describe many new forms than to ascertain the function of one well known form, which may exist in all animals of a class, has tended to keep many departments of natural history in the condition of mere descriptive science. Those who are not professed naturalists appreciate this perhaps more than the naturalists themselves, who are imbued with that enthusiasm which always comes with the earnest study of any one department of nature; for the perusal of those long and laboriously precise descriptions of forms of organs, without the slightest attempt, or even suggestion, as to their uses, affects a physicist with feelings analogous to those experienced by one who peruses a well classified catalogue descriptive of physical instruments, while of the uses of these instruments he is utterly ignorant.

The following views, taken from the "Anatomy of the Invertebrata, by C. Th. v. Siebold," will show how various are the opinions of naturalists as to the location and form of the organs of hearing in the *Insecta*. "There is the same uncertainty concerning the organs of audition (as concerning the olfactory organs). Experience having long shown that most insects perceive sounds, this sense has been located sometimes in this and sometimes in that organ. But in their opinion, it often seems to have been forgotten, or unthought of, that there can be no auditory organ without a special auditory nerve, which connects directly with an acoustic apparatus capable of receiving, conducting and concentrating the sonorous undulations. (The author who has erred most widely in this respect is L. W. Clarke, in Mag. Nat. Hist., Sept., 1838, who has described at the base of the antennæ of *Carabus nemoralis* Illig. an auditive apparatus composed of an *Auricula*, a *Meatus auditorius externus* and *internus*, a *Tympanum* and *Labyrinthus*, of all of which there is not the least trace. The two white convex spots at the base of the antennæ of *Blatta orientalis*, and which Treviranus has described as auditory organs, are, as Burmeister has correctly stated, only rudimentary accessory eyes. Newport and Goureau think that the antennæ serve both as tactile and as auditory organs. But this view is inadmissible, as Erichson has already stated, except in the sense that the antennæ, like all solid bodies, may conduct sonorous vibrations of the air; but, even admitting this view, where is the auditory nerve? for it is not at all supposable that the antennal nerve can serve at the same time the function of two distinct senses.)

"Certain Orthoptera are the only Insecta with which there has been discovered, in these later times, a single organ having the conditions essential to an auditory apparatus. This organ consists, with the Acrididæ, of two fossæ or conchs, surrounded by a projecting horny ring, and at the base of which is attached a membrane resembling a tympanum. On the internal surface of this membrane are two horny processes, to which is attached an extremely delicate vesicle filled with a transparent fluid and representing a membranous labyrinth. This vesicle is in connection with an auditory nerve which arises from the third thoracic ganglion, forms a ganglion on the tympanum, and terminates in the immediate neighborhood of the labyrinth by a collection of cuneiform, staff-like bodies with very finely-pointed extremities (primitive nerve-fibres ?), which are surrounded by loosely-aggregated, ganglionic globules. (This organ has been taken for a soniferous apparatus by Latreille. J. Müller was the first who fortunately conceived that with *Gryllus hieroglyphus* this was an auditory organ. He gave, however, the interpretation only as hypothetical; but I have placed it beyond all doubt by careful researches made on *Gomphoceros*, *Oedipoda*, *Podisma*, *Caloptenus* and *Truxalis*.")

"The Locustidæ and Achetidæ have a similar organ, situated in the fore-legs directly below the coxo-tibial articulation. With a part of the Locustidæ (*Meconema*, *Barbitistes*, *Phancroptera*, *Phylloptera*), there is on each side of this point a fossa, while with another portion of this family there are, at this same place, two more or less spacious cavities (auditory capsules) provided with orifices opening forward. These fossæ and these cavities have each, on their internal surface, a long-oval tympanum. The principal trachean trunk of the leg passes between two tympanums, and dilates, at this point, into a vesicle whose upper extremity is in connection with a ganglion of the auditory nerve. This last arises from the first thoracic ganglion, and accompanies the principal nerve of the leg. From this ganglion in question passes off a band of nervous substance, which stretches along the slightly excavated anterior side of the trachean vesicle. Upon this band is situated a row of transparent vesicles containing the same kind of cuneiform, staff-like bodies, mentioned as occurring with the Acrididæ. The two large trachean trunks of the fore-legs open by two wide, infundibuliform orifices on the posterior border of the prothorax, so that here, as with the Acrididæ, a part of this trachean apparatus may be compared to a *Tuba Eustachii*. With the Achetidæ, there is, on the external side of the tibia of the fore-legs, an orifice closed by a white, silvery membrane (tympanum), behind which is an auditory organ like that just described. (With *Acheta achatina* and *italica*, there is a tympanum of the same size, on the internal surface of the legs in question; but it is scarcely observable with *Acheta sylvestris*, *A. domestica* and *A. campestris*.)"

Other naturalists have placed the auditory apparatus of diurnal lepidoptera in their club-shaped antennæ; of bees at the root of their maxillæ; of *Melolontha* in their antennal plates; of *Locusta viridissima* in the membranes which unite the antenna with the head.

I think that Siebold assumes too much when he states that the existence of a tympanic membrane is the only test of the existence of an auditory apparatus. It is true that such a test would apply to the non-aquatic vertebrates, but their homologies do not extend to the articulates; and besides, any physicist can not only conceive of, but can actually construct other receptors of aerial vibrations, as I will soon show by conclusive experiments. Neither can I agree with him in supposing that the antennæ are only tactile organs, for very often their position and limited motion would exclude them from this function;* and, moreover, it has never been proved that the antennæ, which differ so much in their forms in different insects, are always tactile organs. They may be used as such in some insects; in others, they may be organs of audition; while in other insects they may, as Newport and Goureau surmise, have both functions; for, even granting that Müller's law of the specific energy of the senses extends to the insects, yet the anatomy of their nervous system is not sufficiently known to prevent the supposition that there may be two distinct sets of nerve fibres in the antennæ or in connection with their bases; so that the antennæ may serve both as tactile and as auditory organs; just as the hand, which receives at the same time the impression of the character of the surface of a body and of its temperature; or, like the tongue, which at the same time distinguishes the surface, the form, the temperature and the taste of a body. Finally, I take objection to this statement: "Newport and Goureau think that the antennæ serve both as tactile and auditory organs. But this view is inadmissible, as Erichson has already stated, except in the sense that the antennæ, like all solid bodies, may conduct sonorous vibrations of the air." Here, evidently, Siebold had not in his mind the physical relations which exist between two bodies which give exactly the same number of vibrations; for it is well known that when one of them vibrates, the other will be set into vibration by the impacts sent to it through the intervening air. Thus, if the fibrillæ on the antennæ of an insect should be tuned to the different notes of the sound emitted by the same insect, then when these sounds fell upon the antennal fibrils, the latter would enter into vibration with those notes of the sound to which they were severally tuned; and so it is evident that not only could a properly constructed antenna serve as a receptor of sound, but it would also have a function not possible in a membrane; that is, it would have the power of analyzing a composite sound by the co-vibration of its various fibrillæ to the elementary tones of the sound.

---

* Indeed, they are often highly developed in themselves while accompanied by *palpi*, which are properly placed, adequately organized and endowed with a range of motion suitable to an organ intended for purposes of touch.

The fact that the existence of such an antenna is not only supposable but even highly probable, taken in connection with an observation I have often made in looking over entomological collections; viz: that fibrillæ on the antennæ of noctural insects are highly developed, while on the antennæ of diurnal insects they are either entirely absent or reduced to mere rudimentary filaments, caused me to entertain the hope that I should be able to confirm my surmises by actual experiments on the effects of sonorous vibrations on the antennal fibrillæ; also, the well known experiments of Hensen,* and the inferences of Dr. Johnston from anatomical studies of the antennæ of the Culex, encouraged me to seek in aerial insects for phenomena similar to those Hensen had found in the decapod, the Mysis, and thus to discover in nature an apparatus whose functions are the counterpart of those of the apparatus with which I gave the experimental confirmation of Fourier's theorem, and similar to the supposed functions of the rods of the organ of Corti.

The beautiful structure of the plumose antennæ of the male Culex is well known to all microscopists; and these organs at once recurred to me as suitable objects on which to begin my experiments. The antennæ of these insects are twelve-jointed and from each joint radiates a whorl of fibrils, and the latter gradually decrease in their lengths as we proceed from those of the second joint from the base of the antenna to those of the second joint from the tip. These fibrils are highly elastic and so slender that their lengths are over three hundred times their diameters. They taper slightly, so that their diameter at the base is to the diameter near the tip as 3 to 2.

---

* Studies on the organ of hearing in the Decapoda. "Journal of Scientific Zöology" of Siebold and Kölliker, Vol. xiii.

I cemented a live male mosquito with shellac to a glass slide and brought to bear on various fibrils a $\frac{1}{5}$th objective. I then sounded successively, near the stage of the microscope, a series of tuning-forks with the openings of their resonant boxes turned toward the fibrils. On my first trials with an Ut$_4$ fork, of 512 v. per sec., I was delighted with the results of the experiments, for I saw certain of the fibrils enter into vigorous vibration, while others remained comparatively at rest.

The table of experiments which I have given is characteristic of all of the many series which I have made. In the first column (A) I have given the notes of the forks in the French notation, which König stamps upon his forks. In the second (B) are the amplitudes of the vibrations of the end of the fibril in divisions of the micrometer scale; and in column (C) are the values of these divisions in fractions of a millimetre.

A.	B.	C.
Ut$_2$	·5 div.	·0042 mm.
Ut$_3$	2·5	·0200
Mi$_3$	1·75	·0147
Sol$_3$	2·0	·0168
Ut$_4$	6·0	·0504
Mi$_4$	1·5	·0126
Sol$_4$	1·5	·0126
$\mathrm{B}_4^{\flat-}$	1·5	·0126
Ut$_5$	2·0	·0168

The superior effect of the vibrations of the Ut$_4$ fork on the fibril is marked, but thinking that the differences in the observed amplitudes of the vibrations might be owing to differences in the intensities of the various sounds, I repeated the experiment, but vibrated with lower intensities the forks which gave the greater amplitudes of co-vibration; and although I observed an approach toward equality of amplitude, yet the fibre gave the maximum swings when Ut$_4$ was sounded, and I was persuaded that this special fibril was tuned to unison with Ut$_4$ or to some other note within a semitone of it. The differences of amplitude given by Ut$_4$ and Sol$_3$ and Mi$_4$ are considerable, and the table also brings out the interesting observation that the lower (Ut$_3$) and the higher (Ut$_5$) harmonics of Ut$_4$ cause greater amplitudes of vibration than any intermediate notes. As long as a universal method for the determination of the relative intensities of sounds of different pitch remains undiscovered, so long will the science of acoustics remain in its present vague qualitative condition.* Now, not having the means of equalizing the intensities of the vibrations issuing from the various resonant boxes, I adopted the plan of sounding, with a bow, each fork with the greatest intensity I could obtain. I think that it is to be regretted that König did not adhere to the form of fork, with *inclined prongs*, as formerly made by Marloye; for with such forks one can always reproduce the same initial intensity of vibration by separating the prongs by means of the same cylindrical rod which is drawn between them. Experiments similar to those already given revealed a fibril tuned to such perfect unison with Ut$_3$ that it vibrated through 18 divisions of the micrometer or ·15 mm., while its amplitude of vibration was only 3 div. when Ut$_4$ was sounded. Other fibrils responded to other notes, so that I infer from my experiments on about a dozen mosquitoes that their fibrils are tuned to sounds extending through the middle and next higher octave of the piano.

To subject to a severe test the supposition I now entertained, that the fibrils were tuned to various periods of vibration, I measured with great care the lengths and diameters of two fibrils, one of which vibrated strongly to Ut$_3$, the other as powerfully to Ut$_4$; and from these measures I constructed in homogeneous pine wood two gigantic models of the fibrils; the one corresponding to the Ut$_3$ fibril being about one metre long. After a little practice I succeeded in counting readily the number of vibrations they gave when they were clamped at one end and drawn from a horizontal position. On obtaining the ratio of these numbers I found that it coincided with the ratio existing between the numbers of vibrations of the forks to which co-vibrated the fibrils of which these pine rods were models.

---

* I have recently made some experiments in this direction, which show the possibility of eventually being able to express the intensity of an aerial vibration directly in fraction of Joule's Dynamical Unit, by measuring the heat developed in a slip of sheet rubber stretched between the prongs of a fork and enclosed in a compound thermo-battery. The relative intensities of the aerial vibration produced by the fork when engaged in heating the rubber, and when the rubber is removed, can be measured by the method I described in the Amer. Jour. Sci., Feb., 1873. Of course if we can determine the amount of heat produced per second by a known fraction of the intensity, we have the amount produced by the vibration with its entire intensity. Then means can be devised by which the aerial vibration produced by this fork can always be reproduced with the same intensity. This intensity, expressed in fraction of Joule's unit, is stamped upon the apparatus, which ever afterward serves as a true measure for obtaining the intensities of the vibrations of all simple sounds having the same pitch as itself. The same operation can be performed on other forks of different pitch, and so a series of intensities of different periods of vibration is obtained expressed in a corresponding series of fractions of Joule's unit. Recent experiments have given one one hundred thousandth of a Joule's unit as the approximate dynamic equivalent of ten seconds of aerial vibrations produced by an Ut$_3$ fork, set in motion by intermittent electro-magnetic action and placed before a resonator.

The consideration of the relations which these slender, tapering, and pointed fibrils must have to the aerial pulses acting on them, led me to discoveries in the physiology of audition which I imagine are entirely new. If a sonorous wave falls upon one of these fibrils so that its wave-front is at right angles to the fibril, and hence the direction of the pulses in the wave are in the direction of the fibril's length, the latter cannot be set in vibration; but if the vibrations in the wave are brought more and more to bear athwart the fibril it will vibrate with amplitudes increasing until it reaches its maximum swing of co-vibration, when the wave-front is parallel to its length and therefore the direction of the impulses on the wave are at right angles to the fibril. These curious surmises I have confirmed by many experiments made in the following manner. A fork which causes a strong co-vibration in a certain fibril is brought near the microscope, so that the axis of the resonant box is perpendicular to the fibril and its opening is toward the microscope. The fibril, in these circumstances, enters into vigorous vibration on sounding the fork; but, on moving the box around the stage of the microscope so that the axis of the box always points toward the fibril, the amplitudes of vibration of the fibril gradually diminish, and when the axis of the box coincides with the length of the fibril, and therefore the sonorous pulses act on the fibril in the direction of its length, the fibril is absolutely stationary and even remains so when the fork, in this position, is brought quite close to the microscope. These observations at once revealed to me a new function of these organs; for if, for the moment, we assume that the antennæ are really the organs which receive aerial vibrations and transmit them to an auditory capsule, or rudimentary labyrinth, then these insects must have the faculty of the perception of the direction sound more highly developed than in any other class of animals. The following experiments will show the force of this statement and at the same time illustrate the manner in which these insects determine the direction of a sonorous centre. I placed under the microscope a live mosquito, and kept my attention fixed upon a fibril which co-vibrated to the sound of a tuning-fork, which an assistant placed in unknown positions around the microscope. I then rotated the stage of the instrument until the fibril ceased to vibrate, and then drew a line on a piece of paper, under the microscope, in the direction of the fibril. On extending this line, I found that it always cut within 5° of the position of the source of the sound. The antennæ of the male mosquito have a range of motion in a horizontal direction, so that the angle included between them can vary considerably inside and outside of 40°,[*] and I conceive that this is the manner in which these insects during night direct their flight toward the female. The song of the female vibrates the fibrillæ of one of the antennæ more forcibly than those of the other. The insect spreads the angle between his antennæ, and thus, as I have observed, brings the fibrillæ, situate within the angle formed by the antennæ, in a direction approximately parallel to the axis of the body. The mosquito now turns his body in the direction of that antenna whose fibrils are most affected, and thus gives greater intensity to the vibrations of the fibrils of the other antenna. When he has thus brought the vibrations of the antennæ to equality of intensity, he has placed his body in the direction of the radiation of the sound, and he directs his flight accordingly; and from my experiments it would appear that he can thus guide himself to within 5° of the direction of the female.

Some may assume from the fact of the co-vibration of these fibrils to sounds of different pitch, that the mosquito has the power of decomposing the sensation of a composite sound into its simple components, as is done by the higher vertebrates; but I do not hold this view, but believe that the range of co-vibration of the fibrils of the mosquito is to enable it to apprehend the varying pitch of the sounds of the female. In other words, the want of definite and fixed pitch to the female's song demands for the receiving apparatus of her sounds a corresponding range of co-vibration, so that instead of indicating a high order of auditory development it is really the lowest, except in its power of determining the direction of a sonorous centre, in which respect it surpasses by far our own ear.[†]

---

[*] The shafts of the antennæ include an angle of about 40°. The basal fibrils of the antennæ form an angle of about 90,° and the terminal fibrils an angle of about 30°, with the axis of the insect.

[†] Some physiologists, attempting to explain the function of the semicircular canals, assume, because these canals are in three planes at right angles to each other, that they serve to fix in space a sonorous centre, just as the geometrician by his three coördinate planes determines the position of a point in space. But this assumption is fan-

The auditory apparatus we have just described does not in the least confirm Helmholtz's hypothesis of the functions of the organ of Corti; for the supposed power of that organ to decompose a sonorous sensation depends upon the existence of an auditory nerve differentiated as highly as the co-vibrating apparatus, and in the case of the mosquito there is no known anatomical basis for such an opinion. In other words, my researches show external co-vibrating organs whose functions replace those of the tympanic membrane and chain of ossicles in receiving and transmitting vibrations; while Helmholtz's discoveries point to the existence of internal co-vibrating organs which have no analogy to those of the mosquito, because the functions of the former are not to receive and transmit vibrations to the sensory apparatus of the ear, but to give the sensation of pitch and to decompose a composite sonorous sensation into its elements; and this they can only do by their connection with a nervous development whose parts are as numerous as those of the co-vibrating mechanism. Now as such a nervous organization does not exist in insects, it follows that neither anatomical nor functional relations exist between the co-vibrating fibrils on the antennæ and the co-vibrating rods in the organ of Corti, and therefore, that neither Hensen's experiments on the Mysis (assumed by Helmholtz to confirm his hypothesis), nor mine on the mosquito, can be adduced in support of Helmholtz's hypothesis of audition.[*]

The above described experiments were made with care, and I think that I am authorized to hold the opinion that I have established a physical connection existing between the sounds emitted by the female and the co-vibrations of the antennal fibrillæ of the male mosquito; but only a well established physiological relation

---

ciful and entirely devoid of reason; for the semicircular canals are always in the same dynamic relation to the tympanic membrane, which receives the vibration to be transmitted always in one way through the ossicles to the inner ear. Really, we determine the direction of a sound by the difference in the intensities of the effects produced in the two ears, and this determination is aided by the form of the outer ear and by the fact that man can turn his head around a vertical axis. Other mammalia, however, have the power of facilitating the determination of motion by moving the axis of their outer ears into different directions. It is also a fact that when one ear is slightly deaf, that the person unconsciously so affected always supposes a sound to come from the side on which is his good ear.

[*] Also, the organ of Corti having disappeared in the lower vertebrates, it is not likely that it would reappear in the articulata; and especially will this opinion have weight when we consider that the peculiar function of the organ of Corti is the appreciation of those composite sounds, whose signification mammals are constantly called upon to interpret.

between these co-vibrating parts of the animal and the development of its nervous system will authorize us to state that these are really the auditory organs of the insect. At this stage of the investigation I began a search through the zoological journals, and found nearly all that I could desire in a paper, in vol. iii, 1855, of the Quarterly Journal of the Microscopical Society, entitled "*Auditory apparatus of the Culex Mosquito*, by Christopher Johnston, M. D., Baltimore, U. S."

In this excellent paper I found clear statements showing that its talented author had surmised the existence of some of the physical facts which my experiments and observations have established.* To show that anatomical facts conform to the hypothesis that the antennal fibrils are the auditory organs of the mosquito, I cannot do better than quote the following from Dr. Johnston's paper:

"While bearing in mind the difference between *feeling a noise* and *perceiving a vibration*, we may safely assume with Carus—for a great number of insects, at least,—that whenever true auditory organs are developed in them, their seat is to be found in the neighborhood of the *antennæ*. That these parts themselves are, in some instances, concerned in collecting and transmitting sonorous vibrations, we hold as established by the observations we have made, particularly upon the *Culex mosquito;* while we believe, as Newport has asserted in general terms, that they serve also as tactile organs.

"The male mosquito differs considerably, as is well known, from the female; his body being smaller and of a darker color, and his head furnished with *antennæ* and *palpi* in a state of greater development. (Fig. 92.) Notwithstanding the fitness of his organs for predatory purposes, he is timid, seldom entering dwellings or annoying man, but restricts himself to damp and foul places, especially sinks and privies. The female, on the other hand, gives greater extension to her flight, and attacking our race, is the occasion of no inconsiderable disturbance and vexation during the summer and autumn months.

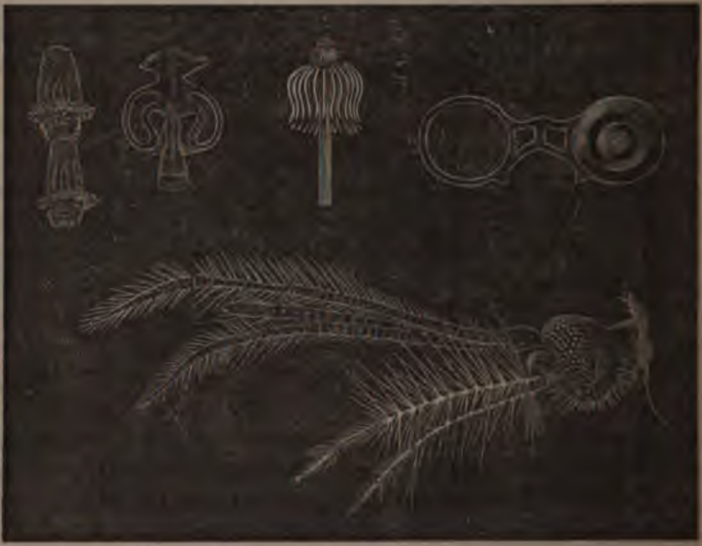
"The head of the male mosquito, about 0·67 mm. wide, is provided with lunate eyes, between which in front superiorly are found two pyriform capsules nearly touching each other, and having implanted into them the very remarkable antennæ.

---

* A short time before the death of my friend, Prof. Agassiz, he wrote me these words: "I can hardly express my delight at reading your letter. I feel you have hit upon one of the most fertile mines for the elucidation of a problem which to this day is a puzzle to naturalists, the seat of the organ of hearing in Articulates."

"The capsule, measuring about 0·21 mm., is composed of a horny substance, and is attached posteriorly by its pedicle, while anteriorly it rests upon a horny ring, united with its fellow by a transverse fenestrated band, and to which it is joined by a thin elastic membrane. Externally it has a rounded form, but internally it resembles a certain sort of lamp shade with a constriction near its middle; and between this inner cup and outer globe there exists a space except at the bottom or proximal end, where both are united.

Fig. 92.



Auditory Apparatus of the Mosquito.

"The antennæ are of nearly equal length in the male and the female.

"In the male, the antennæ is about 1·75 mm. in length, and consists of fourteen joints, twelve short and nearly equal, and two long and equal terminal ones, the latter measuring (together) 0·70 mm. Each of the shorter joints has a fenestrated skeleton with an external investment, and terminates simply posteriorly, but is encircled anteriorly with about forty *papillæ*, upon which are implanted long and stiff hairs, the proximal sets being about 0·79 mm. and the distal ones 0·70 mm. in length; and it is beset with minute bristles in front of each whorl.

"The two last joints have each a whorl of about twenty short hairs near the base.

"In the female the joints are nearly equal, number but thirteen, and have each a whorl of about a dozen small hairs around the base. Here, as well as in the male, the parts of the antennæ enjoy a limited motion upon each other, except the basal joint, which, being fixed, moves with the capsule upon which it is implanted.

"The space between the inner and outer walls of the capsule, which we term confidently the auditory capsule,* is filled with a fluid of moderate consistency, opalescent and containing minute spherical corpuscles, and which probably bears the same relation to the nerve as does the lymph in the scalæ of the cochlea of higher animals. The nerve itself, of the antenna, proceeds from the first or cerebral ganglion, advances toward the pedicle of the capsule in company with the large trachea, which sends its ramifications throughout the entire apparatus, and, penetrating the pedicle, its filaments divide into two portions. The central threads continue forward into the antenna, and are lost there; the peripheral ones, on the contrary, radiate outward in every direction, enter the capsular space, and are lodged there for more than half their length in *sulci* wrought in the inner wall or cup of the capsule.

"In the female the disposition of parts is observed to be nearly the same, excepting that the capsule is smaller, and that the last distal antennal joint is rudimental.

"The proboscis does not differ materially in the two sexes; but the palpi, although consisting in both instances of the same number of pieces, are very unlike. In the female they are extremely short, but in the male attain the length of 2·73 mm.; while the proboscis measures but 2·16 mm. They are curved upward at the extremity.

"* * * The position of the capsules strikes us as extremely favorable for the performance of the function which we assign to them; besides which there present themselves in the same light the anatomical arrangement of the capsules, the disposition and lodgment of the nerves, the fitness of the expanded whorls for receiving, and of the jointed antennæ fixed by the immovable basal joint for transmitting, vibrations created by the sonorous undulations. The intra-capsular fluid is impressed by the shock, the expanded nerve appreciates the effect of the sound, by the quantity of the impression; of the pitch, or quality by the consonance of particular whorls of stiff hairs, according to their lengths; and of the direction in which the undulations travel, by the manner in which they strike upon the antennæ, or may be made to meet either antennæ in consequence of an opposite movement of that part.

---

*See fig 92.

"That the male should be endowed with superior acuteness of the sense of hearing appears from the fact, that he must seek the female for sexual union either in the dim twilight or in the dark night, when nothing but her sharp humming noise can serve him as a guide. The necessity for an equal perfection of hearing does not exist in the female; and, accordingly, we find that the organs of the one attain a development which the others never reach. In these views we believe ourselves to be borne out by direct experiment, in connection with which we may allude to the greater difficulty of catching the male mosquito.

"In the course of our observations we have arrived at the conclusion, that the antennæ serve to a considerable extent as organs of touch in the female; for the palpi are extremely short, while the antennæ are very movable, and nearly equal the proboscis in length. In the male, however, the length and perfect development of the palpi would lead us to look for the seat of the tactile sense elsewhere, and, in fact, we find the two apical antennal joints to be long, movable, and comparatively free from hairs; and the relative motion of the remaining joints very much more limited."

My experiments on the mosquito began late in the fall, and therefore I was not able to extend them to other insects. This spring I purpose to resume the research, and will experiment especially on those orthoptera and hemiptera which voluntarily emit distinct and characteristic sounds.

THE GOSSAMER SPIDER.*

BY DR. G. LINCECUM.

DECEMBER is, in Texas, the month for ballooning spiders to emigrate. Webster says, "gossamer, a fine, filmy substance like cobwebs floating in the air, in calm, clear weather, especially in autumn, and is probably formed by a species of spider." Pretty good for a dictionary maker. But he didn't know how it happened to be floating in the air.

Sure enough, that fine, filmy substance is formed by a little spider. I have seen them making it. It is a balloon, and if Webster had caught one of those floating locks of gossamer before it reached a landing place, he would have found the little aeronaut and half a dozen young ones aboard of it. The balloon is the plan adopted by that particular species of Arachnidæ, to scatter widecast its young ones.

This species of spider constructs nets and snares, and, like many other species of the family, its net is circular, very regularly and systematically constructed, and thoughtfully placed in an open passage way, seven or eight feet from the ground between two bushy trees, and above the contingency of being broken by a roaming cow or loose horse.

In setting and establishing the two first brace lines between the two trees it has selected for its net, it displays much sagacity and ingenuity, with a thorough knowledge of the powers of the wind, and the best possible method and position to avail itself of its uses. Climbing up the tree situated to the windward, it takes position, at the proper elevation on the point of the longest twig it can find that projects towards the other tree of its selection; and spinning one of its gossamer webs of the proper length, patiently waits for a breath of air to waft it across the vacant space of ten to twenty feet and lash its viscid extremity to some projecting twig or leaf of the opposite tree. It holds the line in its hand, feels when it strikes, and instantly making the home end fast, strikes out boldly on the microscopic thread, lets go another thread as she travels, and is soon observed lashing down the ends of the now double line, to a twig of the other tree. This done, it runs back and forth on it, spinning a thread every trip until the line is ten or fifteen ply.

---

*Communicated by the author to the Smithsonian Institution and published by permission of Prof. Henry.

It now places itself on another twig of the windward tree, as nearly under the first line as possible and six or eight feet below, lets go another thread. As soon as it feels it has caught on the opposite tree it fastens down the home end, and hastens to reënact all we saw it perform on the first line. It seems to be much elated and encouraged by its successes, and, now hurriedly, is seen climbing up the first tree, and very soon is engaged at work as near the middle of the upper line, as could have been obtained by actual measurement. Soon it is observed descending spinning out a thread as it goes, it being safely fastened to the upper line. It swings down until it is somewhat below the lower line; but finds that the thread it hangs on, is half a yard or more to one side of its lower line. It now, after a moment's reflection, attempts to swing, pendulum-like, at the end of its thread to and from the lower line. The spider soon ascertained that success did not lie in that experiment; and wound up the thread it was hanging on until it regained its position on the middle of the upper line. It was very nearly calm, and it rapidly spun out a long wet thread, which, light as was the breeze, passed above the lower brace line. It was however continuously extended until it struck amongst the brush some distance away. The ingenious little workman continued to spin out the thread, until the slack of it bending down came in contact and adhered to the lower line. Feeling the entanglement, it immediately ran down, cut and cast loose the surplus end of the thread, carried the end in hand to a point at right angles with the attachment to the line above, made it fast, then quickly ran about a yard along the lower brace, attached a thread, returning, ran up the middle line, thence along the upper brace to a point perpendicular to where it had attached the thread in hand to the lower brace, drew up the slack and made it fast. Then passing on the upper brace to a point about a yard beyond the middle dropped line, made a thread fast and returning descended the middle line, carrying the thread to a point at right angles with its attachment above, and giving it the proper tension, made it fast. And now, laying three or four threads on each of these three stay lines, the balance of the work, though tedious, was easily accomplished.

After laying the radiating lines, it goes down to the centre, and carefully measuring with its right hind leg, seizes with its foot one of the lines, and drawing it down forcibly, until it touches the web vent; it adheres and is instantly let go. In its recoil, there is seen to be drawn out a milk like substance; this lessens into a very fine web which instantly dries. It then moves onwards to the next line and with the same hind foot seizes it at the proper measurement, draws it down as before until it touches the web fount, lets it recoil and spin out the gossamer web; and so on, from line to line, measuring the meshes exactly the same distance moving to the left; the circular line is put on spirally.

The gossamer spider will weigh near two grains; it is well formed, of a grayish pea green, the legs rather long. Quick in its movements, but a little timid; it will drop its work and run on the approach of a stranger. One species of mud dauber destroys multitudes of the gossamer spiders.

When, in the last days of November there comes a clear day, temperature 60° Fah. wind gently from the south; at about one o'clock, P. M., and afterwards during the succeeding three hours, may be seen, in this latitude at various heights and distance, very many white locks of gossamer floating smoothly in the air, all going with the wind. These are the balloons of the gossamer spider. And there is a mother and half a dozen or more young spiders aboard of every one of them.

Each balloon is furnished with two long lines at the forward end, which may be seen, waving and flapping in the wind as they fly, and seeming to aid in preserving the equable position of the light floating craft.

Towards four o'clock, P. M., the spectator will observe that the balloons are beginning to descend; and at the same time he will see great numbers of long glittering webs, detached and floating at random all rising higher as they go on with the wind.

Meanwhile the balloons with their freight are whirling, not very rapidly downwards, until they strike some tall weed or grass, when they become entangled, and the passengers instantly leap out, and spinning out a web swing themselves down to the ground.

If the observer is near enough when the balloon strikes he can see all this.

I have noticed these balloons, when the wind was brisk passing very rapidly, at an altitude of one or two thousand feet. There is no telling where they came from or how far they might float. 150, or 200 miles perhaps. Thus is scattered the species over vast districts, which, no doubt, is the object of their aeronautic journey.

When they intend to make an ascension, they fix themselves on some extreme point of the branch of a tree, or weed or corn tassel; there carefully spin out a lock of white gossamer five or six inches long and two inches wide in the middle, tapering towards the ends; holding it all the time in the gentle breeze by a thread two or three inches long, which, being attached to the end of the selected point, detains the balloon until it is finished. They then spin out at the bow two lines thirty or forty feet in length, another at the stern twenty or thirty feet long, then cut the cable and float briskly upwards and forwards on an inclined plane.

I once observed one of these spiders at work on the upper corner of an open, outside door shutter. She was spinning gossamer, of which she was forming a balloon; and clinging to her thorax was a little cluster of minute, young spiders. She finished up the body of the balloon; threw out the long bow lines, which were flapping and fluttering on the now gently increasing breeze, several minutes before she got all ready for the ascension. She seemed to be fixing the bottom and widening her hammock-shaped balloon. And now the breeze being suitable, she moved to the cable in the stern, severed it, and her craft bounded upwards and soaring away northwards, was soon beyond the scope of my observation. I was standing near when it was preparing to cast loose the cable; and had thought I would arrest its flight but it bounded away with such a sudden hop, that I missed and it was gone.

ON THE NESTING OF CERTAIN HAWKS, ETC.

BY DR. ELLIOTT COUES, U. S. A.

In a recent number of the Naturalist I gave some account of the nidification of Swainson's buzzard (*Buteo Swainsoni*), but had nothing to say of the eggs, as I took the field last season too late for them. The present year I have secured numerous sets, and noticed an interesting variation from the usual mode of nesting, necessarily brought about by the entire absence of trees. In Montana, as in most of Dakota, Swainson's buzzard occurs in great numbers over large areas of almost unbroken, arid and cactus-ridden prairie, where, even along the water-courses, there may be no trees or bushes for many miles. Several of the northern tributaries of the Milk river, which we have crossed this season, are entirely unwooded; the streams cut their sinuous course deep into the loose soil of the prairie, making on the convexity of almost every turn a bold perpendicular earth-bank a hundred feet, more or less, in height. To these "cut-banks" as they are called, Swainson's and some other hawks, to be presently mentioned, resort to breed. The nest is composed of small sticks—the stems of sage brush and other rank weeds—with grasses, etc., and is of the usual size and shape; it rests directly on the earth of some little projecting shelf of ground, generally near the top of the embankment. The eggs of this bird I have taken, fresh and in various stages of incubation, from the latter part of June till the middle of July. No one of the numerous sets contained more than two eggs; this is obviously the usual complement, in this latitude at least, though presumably not the maximum. In one instance, I found but a single egg in the nest, so far advanced in incubation that I was satisfied no other would have been laid. These eggs differ, furthermore, from what I believe to be the rule in this genus, in being nearly colorless and unmarked. They are quite like hens' eggs in general appearance, as well as in size and shape. Most of my specimens are uniform dull white, with no more evident markings than such obsolete grayish spots as are frequently observed in the eggs of the marsh hawk (*Circus cyaneus Hudsonicus*); a few have some obvious dirty-brown scratchy spots, in every instance at the small end; none are marked all over, nor are any of them strongly blotched at all. It would have been impossible to predicate the normal character of these eggs upon any rule which might be supposed to hold in this genus. Plain colorless eggs, the well-known exceptions in the cases of many or most species of Buteo, are here the rule.

It may not be generally known that the ferruginous buzzard (*Archibuteo ferrugineus*) which is accredited, and properly so, with a decidedly western range, is a common species of eastern Montana and the adjoining portions of Dakota, in latitude 49°. I have frequently seen it this summer along the northern tributaries of Milk river, where I have secured some fine specimens of old and young, and observed its nidification. This is precisely the same as that of *Buteo Swainsoni*, the nest which I found being placed on a little projection on the face of an earth bluff. It contained three young, about ready to take flight, July 18th.

I was still more surprised to find yet a third species of hawk nesting in the same unusual manner. This was the peregrine falcon or duck hawk (*Falco communis*), a bird whose nidification, under varying circumstances, has occasioned some little controversy, and entered into the discussion of the relationship of the American to the European form. I was much gratified to discover the nest, which very few ornithologists have seen in this country, and to note how readily the bird adapted itself to its special surroundings. In this region the falcon may be truthfully said to nest *on the ground;* yet we must remember that it is merely the replacing by an earthen embankment of the rocky crags where the bird is described as usually nesting. In effect the location is the same. One of the two nests I found was almost within rifle-shot of the two spots where Swainson's and the ferruginous buzzard were respectively nesting. It was almost a burrow in the ground, so completely was it hidden on a little shelf of earth beneath a projecting mass, and further concealed by a tall column of earth nearly washed away from the face of the bank. This nest contained three young ones, just able to fly. On lowering a man down by a rope over the brow of the bank, they left the nest and circled about till two were shot; one parent had been already destroyed; the other was not seen. The third young one was afterward brought to me by a soldier who had managed to capture it alive; it is still in my possession, and is proving itself a spirited and enterprising prisoner. The other nest was on the bare face of a perpendicular embankment, on a slight shelf about twelve feet below the top. It likewise contained three young (July 19th), not yet able to leave the nest. Both parents hovered overhead with loud harsh cries; the male kept at a respectful distance, but the mother bird, more intrepid in the defence of her home, menaced me at close range, till, at one of her swoops, I brought her to the ground. I endeavored without success to lasso the young ones out of the nest; they repeatedly cleared themselves of the noose just as it began to draw upon them; and as the crumbling state of the bank rendered descent to the nest too dangerous to be tried, I left the family to the care of the father, who, it is to be hoped, has since done more for his family than he did on the occasion just mentioned.

The character of the embankments on which all these hawks nested may be perfectly indicated in the fact that they were also the resort of myriads of cliff swallows (*Hirundo lunifrons*). Thousands of the swallows' nests patched the face of the banks in various places; one large cluster was noticed near a buzzard's nest; while another group was affixed within a few feet of one of the falcon's nests. I was not long enough on the spot to determine whether the swallows were fond of their bold and powerful neighbors or not.

In speaking of this unusual association of swallows and falcons, I am reminded to note a somewhat similar arrangement between a pair of Arkansas flycatchers, and Swainson's buzzard; their nests being in the same tree and but a few feet apart. Both birds were incubating at the time of my visit.

The Arkansas flycatcher (*Tyrannus verticalis*), is one of the commonest of the small birds along the Upper Missouri and the wooded parts of the Milk river and its tributaries. So far as I have observed, however, it will not go into an entirely treeless country. In travelling over the prairie, no sooner do we strike a "*coulé*" (ravine) with scattered cottonwoods and box-elders, than we hear the shrill cries of these birds; and the nest—or several of them—may usually be soon discovered, the nest being bulky, and the trees straggling, with thin foliage. These birds lay later than most species in this country. I have taken fresh eggs up to the middle of July, and am sure there was no previous brood. The nests are in a fork or crotch, generally far out on the limb, but sometimes directly against the trunk; and at any height from five or six to forty or fifty feet. The common kingbird is generally seen in company with this species; I have taken both nests from the same tree. The eggs of the two are indistinguishable; nor can the nests be told apart with certainty; though on an average the Arkansas is the larger, softer and fluffier, with more weedy and downy material and fewer slender rootlets; it is also rather less compactly built. The eggs run from three to six in number. With the same general habits, these two flycatchers may instantly be recognized by the voice; that of the Arkansas is much harsher and louder than that of the common kingbird, which more nearly resembles the twittering of a martin. The difference is very noticeable when the two species are hovering together overhead, bewailing the spoliation of their homes.

Our common kingbird may be added to the long list of the cowbird's victims, and to the shorter catalogue of those ingenious birds who get rid of the obnoxious egg by building a two-story nest. I have such a one in my collection, with a cowbird's egg safely shut up in the basement.

Nothing that I am aware of has been entered upon the records respecting the nidification of the mountain plover (*Eudromias montana*). I find it breeding quite commonly in all the region immediately north of the Milk river, and extending at least as far east as the mouth of this river. It nests on the open prairie, in June and July. There is nothing peculiar in the nidification; the nest is merely a slight depression, lined with a few grass blades. The only set of eggs I have contains three; and as I have several times noticed the parent leading her brood of three young over the prairie, I conclude that this number, and not four, is the usual complement, in this latitude at least. The eggs are as described in my late work; they are rather peculiar, and little liable to be confounded with those of any of the allied waders. When startled from the nest the bird makes off crouching low, running swiftly but with frequent pauses, and uttering meanwhile a low chattering note, quite unlike the ordinary soft mellow cry. As I have said, the bird nests anywhere on the dry prairie; but if it have any preference, it is for the stretches of low loose grassy ground where the prairie dogs settle, as distinguished from the more arid and gravelly or stony prairie. The period of nesting must be protracted; for I have taken nearly fresh eggs at the same time that I saw broods running about, and but a few days before well feathered young, no longer under charge of the parent were obtained.

The numberless alkaline pools or small lakes with which portions of Dakota and Montana are cursed are the favorite breeding resorts of two very elegant and interesting birds; the avocet, and Wilson's phalarope. These two species are always intimately associated in my mind, so frequently have I found them together, not only in this region, but in Kansas and other parts of the west. The avocet is one of the most conspicuous birds of the saline regions of our Territories. In flight we recognize it at any distance by its resemblance to a miniature crane; its body white, and wings black, its long blue legs stretched stiffly straight behind, and the measured sweep of its ample wings, unlike the quicker beats of the thin, pointed pinions of its allies. Its voice is also characteristic; the harsh noise is incessant when the breeding places are invaded. This bird must nest quite early; as I found no eggs, and by the middle of July well grown and completely feathered young birds were flocking. These may be distinguished from the adults among other marks, by the curiously swollen condition of the shank; the upper part of the tarsus being two or three times as thick as the tibia. It is much the same with the phalaropes and other waders. As regards the singular bill of the avocet, the amount of curvature of which has occasioned no little discussion, I may observe that I have shot some birds with the bill about as much curved as it is represented to be in Wilson's figure, which has been severely criticised, and others with the bill as straight as Audubon drew it; nor was the difference, so far as I could see, anything more than fortuitous. The degree of swimming power the avocet possesses has also been variously estimated. The bird generally wades about after its food; but on striking a deep place begins to swim without the slightest hesitation; and moreover, I have seen it alight from on wing on deep water, and swim about as freely as a duck. In this respect, the avocet and the phalarope are about on a par.

One of the most generally diffused of the birds that breed along the Upper Missouri and in the Milk river region is the long-billed curlew (*Numenius longirostris*). I have travelled for days together and scarcely lost sight of these birds for an hour, during the daytime; while at night their piercing and lugubrious cries resounded to the howling of the wolves. There is something peculiarly melancholy, and almost foreboding, in their screams, heard in these remote wilds, where the traveller is never entirely free from a sense of contingent danger. The birds breed anywhere on the broad prairie—perhaps oftenest in the vicinity of pools and sloughs, but not necessarily near water. The eggs are mostly laid in June, but there is a wide range in the time. Thus I have taken a set in July, having previously caught young birds. These, like other waders when young, have a curiously clumsy and gawky appearance when running over the prairie, as if their legs were too long and heavy to be easily managed. They may readily be caught during the first week or two. At this age the bill is about two inches long, comparatively stout throughout, and scarcely decurved.

Among the smaller birds of the boundless prairie, a few species are specially notable. The commonest and most universally diffused is the western horned lark (*Eremophila alpestris leucolæma*); we find it breeding everywhere. It begins to lay very early; the curiously speckled young ones, quite unlike the adults, may be taken any time in June, already flying; while eggs (doubtless of a second brood) may be secured through July. The mode of nesting of the larks, and of the three most conspicuous prairie *fringillaries*, is substantially the same. The three to which I refer are the bay-winged bunting (*Pooecetes gramineus confinis*), the chestnut-collared bunting (*Plectrophanes ornatus*) and Maccown's bunting (*P. Maccownii*). These two *Plectrophanes* are the most characteristic of the prairie sparrows, and are found together in abundance in most of the regions here under consideration. *P. ornatus* however, is rather the more easterly of the two. Thus, it is common all over northern Dakota and the eastern part of Montana; while I have seen none since I came the first few miles up the Milk river, where *P. Maccownii* increases in numbers, then becomes the prevailing, and finally the only species. The chestnut-collared has a very pretty habit of soaring, like Sprague's lark, while the female is incubating, singing in the air, and letting itself gradually down like a parachute, with the wings stretched upward at a right angle with each other—an action that displays the glossy black of the under parts and the white of the tail to the best advantage. Floating thus lightly in the air they remind one of butterflies; and their song, though not of the highest excellence, is sweet, gladsome and musical.

Great numbers of water-fowl stay their flight to nest in the pools and sloughs of our Northern Boundary; among them may be mentioned mallards, widgeons, shovellers, teals, pintails, scaups, buffle-heads and wild geese. To resume the subject with which this slight article began, namely, exceptional modes of nesting, I would say that the geese of this region sometimes nest on the ground around the ponds, as geese ordinarily do, and then again they sometimes *nest in trees*, somewhat like wood ducks, only that they do not enter holes for this purpose. Arboreal nidification of geese sounds strangely, but it is nevertheless true; and it is a well known circumstance to those persons who inhabit the country, however unenlightened ornithologists may be in the matter. It furnishes a case parallel with that related by Audubon, of the herring gull nesting in communities, in trees.

I will conclude with an observation on the digestive arrangements of the sage cock — a bird which I have only lately seen alive. It has been repeatedly stated to feed exclusively upon sage leaves. All those I shot had the craw full of grasshoppers and other insects, and had nothing else in it. It has also been asserted that the bird has no gizzard; the gizzard is indeed quite thin, so as to appear merely a membranous bag, but for all I could see that the disposition of the muscles is the same as that obtaining in other gallinaceous birds. The case is simply a reduction of the amount of muscle, without any essential change in arrangement. At least this is the result of an off-hand dissection, such as one would be likely to make in the field. The change is an evident adaptation to the soft and succulent or juicy nature of the bird's food — buds, leaves and insects, instead of grain. There is another peculiarity of this bird, also dependent upon its food, and the nature of the digestive process. When flushed it almost invariably acts in the way which has given the green heron (*Ardea virescens*) its inelegant popular appellation.— *Milk River, at* 49°, *July* 25, 1874.

THE METAMORPHOSIS OF FLIES.* I.

BY DR. AUGUST WEISSMAN.

Before I pass to the general results of the foregoing observations a short chronological exhibit of all the processes of development will be useful.

In agreement with all the earlier observations on the embryology of other insects it is apparent that during the life of the larva, in its outer form as well as the internal organs, only the

---

*Though Weissman's famous work, "The Development of Diptera," was published as long ago as 1864, yet we feel sure our readers will value the translation of a few of the concluding chapters which have not previously been rendered into English. The present chapter is entitled "View of the Phenomena of Development."—A. S. P.

phenomena of growth are manifested, and not a deeper reaching metamorphosis. As the enlargement of an organ by simple growth in the Vertebrates is allied with a new formation of blood vessels, so here the origin of a new trachea is accompanied by the speedy enlargement of muscles and intestine, and with this very important continual increase of the net-work of tracheæ is combined an expansion and increase in volume, so that after the first moulting, on the anterior end of the body, a new pair of stigmata are formed, while the aperture in the hinder one is doubled, and after a second moulting, a three-fold aperture is made.. Accompanying this is a certain change in the apparatus of hooks arming the mouth of the larva. All these changes are not of great importance; they lead to no new feature in the organization of the animal; they are series of processes which precede the formation of entirely new organs or parts. Transformation in this last sense occurs only in those parts of the larva, out of which the parts of the adult insects are developed. *The genital glands, as well as the outer skin of the segments bearing the appendages of the fly's body, are already formed in the larva; indeed they are even formed during the development of the embryo.*

We find ourselves in fact almost going back to the encasement theory of Swammerdam, who believed that the larva, pupa and butterfly were imprisoned from the very first in each other, and came to light by the successive casting off of each skin. It is in fact only this, that the parts of the fly* do not all lie perfectly formed within the larva, but exist only as rudiments, and that only a part of the body of the fly is newly formed, while some of the parts will be produced out of the larva. The head and thorax with their appendages are formed within the larva by the gradual development of special cell masses. The abdomen, however, arises through a simple change of a number of larval segments. The head and thorax arise not as a whole out of a single cell mass, but in separate pieces, out of which after pupation the whole form is perfected.

The head arises out of two groups of cells which originate from a nervous filament sent off from the supra-œsophageal ganglion; but each segment of the thorax arises out of four separate groups of cells which are partly inserted in the course of a slender filament, and are in part blended with the peritoneal skin of a trachea.

---

* This chapter relates wholly to *Musca vomitoria*.

These collections of cells form flat disk-like bodies which are enclosed in a structureless membrane and may be termed the *imaginal disks.* In each imaginal disk of the thorax arises a quarter of a segment with the appendage belonging to it; the two imaginal disks of the head, the appendages of the brain, unite themselves into a hinder division, the eye-disks; and an anterior which forms the germ of the antennæ and remaining portion of the head.

The pupation in Sarcophaga occurs eight or ten days after the exclusion of the larva from the egg. It is accompanied by a marked contraction of the whole body, with an infolding of the first segments.

Under the hardened, barrel-shaped, larva skin [puparium], the true pupa is formed, *i. e.*, the body of the fly enclosed by a special membrane, the pupa-sheath. The process of formation of the body of the fly, while thus enclosed, lasts for four days after the pupation. Then it reaches that stage which in the development of the butterfly is shown by a stripping off of the larva skin, and the *formation* of the pupa is ended; then begins the *development* of the same. This consists in the building up of the external form of the body, and in establishing the position and development of the internal organs. This period can be divided into two sections, which are here described chronologically. The first division consists of the more delicate modelling of the outer form. Hitherto the insect has appeared only in its crudest shape, the appendages of the thorax and head are but rudimentary, neither attaining their full size, nor their definitive form. All these parts are now entirely formed, and are matured in from two to seven days, and already covered with colorless hairs and bristles.

The second division covers the period of the eighth to the twentieth day, during which time the inner organs are completed, and the outer surface of the body assumes its peculiar colors.

The first period, that of the formation of the pupa, lasting from one to four days, begins with the destruction of the four anterior segments of the larva. The hypodermis which gives it its form is loosened, the muscles of the body-walls, as also of the pharynx, the cellular walls of the pharynx itself, the anterior part of the œsophagus, with the sucking stomach, follow next. During this time the thoracic pieces are developed from the imaginal disks; they give origin to the appendages, which are indeed very short, but still each joint can be distinguished, and are nothing but a projection outwards of these same thoracic pieces. However here — as we had until now thought — the appendages of the imago do not result from a simple thrusting out of the larval hypodermis, as would seem to be correct in a morphological view, which would consider the appendages of the insectean body as projections of the skin, during their development not aborted, but persistent. They are in fact still, however, projections outwards of the skin, though they are formed at a time when the skin has not grown into closed segments. Still we find at the end of the second day the formative disks of the thorax appended to their pedicels (nerves, tracheæ) in the form of swollen transparent vesicles, and within them the thoracic pieces to which they are closely related, with its appendage, can be easily observed. In three days they have attained their perfection, the skin peels off and falls away, and they now become three completed rings, the thoracic segments. At the same time the tracheæ of the larva are thrown off, and then begins the formation of a peculiar tracheary system, which performs its functions only during the pupal period. In its trunks and larger branches it resembles the larval system, but in the terminal rings is unlike anything else. In this respect their structure is very peculiar, in that all the ends project freely into the liquids of the body, and nowhere, as before, do they send fine branches to the different organs. The filling of the new system of air vessels with air does not go on during the remaining moultings, through a removal of the old proximal tubes (*intimaröhren*); this cannot be completely seen during the life of the pupa, but through the cross division of the proximal tubes (*intimaröhren*) in a determined place of the stem near the anterior stigmata.

At the third day the three segments of the thorax unite to form a small ring which posteriorly coalesces with the edge of the fifth larval segment; but the anterior edges are puffed up and are open. In the opening lie loose the chitinous parts of the mouth parts, the apparatus of hooks. The head of the fly is not yet to be seen, but the rudiments of the same are still visible within the thorax. In the two formative disks of the body, which we would consider as appendages to the brain, develop into a vesicle containing the œsophagal ganglion, the head-vesicle, on which the eyes and antennæ are already indicated, and from under whose hinder edge the proboscis grows out. On the fourth day the head, which has advanced forwards from within the thorax, comes to light, and is accompanied by an uninterrupted, strong contraction of the eight hinder segments of the larva still contained within. These last are shortened, and soon assume the form of the abdomen of the adult fly. The head thus presses forwards out of the thorax, keeps pace in development with the thorax; the body of the pupa then lies as a whole contained within the puparium, and thus indicates the end of the first period.

The process of development of the first four days is confined not wholly to the outer crust of the body, but also to the new remodelling, or transformations of some of the inner organs. The nervous centres which had been separated in the larva here become united; an infra-œsophageal ganglion separates (abschnürt) from the ventral cord, and the upper (supra-œsophageal ganglion) divides into two divisions, of which the outer may be considered the central organ of the sense of sight (ganglion opticum) and as the bulb of the compound eyes.

All the anterior and middle portion of the alimentary canal sloughs off, and at the end of four days becomes renewed. This happens only to the œsophagus and chyle-stomach, while the proventricalus and cæcal appendages of the stomach are not thus reproduced. They break up cell by cell; these cells are carried into the chyle-stomach forming there a compact mass, which is surrounded with a peculiar covering, as if encysted. They do not fill up the cavity, but swim in a honey-like liquid which by this time will have been secreted by the cells of the walls. Here the cells are preserved, though the organ is destroyed, thus the reconversion is effected in the walls of the chyle-stomach. Each cell decays by fatty degeneration and in the place of the old cells arise new ones which rebuild the organ. The destruction of the cells is accompanied by a contraction of the muscular walls, and thereby an important shortening of the organ is produced. Next these muscles as well as the tracheæ decay, many branches of which are interwoven around the stomach of the larva; the alimentary canal remains without air-vessels until the last day of the pupa state. As soon as the abdomen has formed, by the contraction of the subcutaneous muscles of the last eight larval segments, the muscles disappear, and at the same time, namely, during the advance of the head, at which time also the nervous centres become pushed forward; they tear away also the degenerated nervous branches, whose terminal threads likewise become destroyed with the organs in which they ramify. Of the influence of the nervous system on the entire organism, there is nothing to be said since the change of form of the central parts is accompanied by a complete histological transformation, as the interpenetration of their cell masses with fat demonstrates.

The dorsal vessel does not now perform its functions. The animal now consists of a thin cellulose skin, with its contents partly destroyed, in part completely destroyed, and in part already concerned in the new formation of the organs. The entire fat body, cellulose tissue, of the larva, is lost in a liquid mass of fat globules and nuclei, and they are mingled with the decaying muscles, tracheæ, etc. At the end of the first period the contents of the pupal body may be well compared with the contents of the fertilized egg. All visible traces of animal life have ceased; the action of the centres of the expression of animal life is suspended, and out of this chaos of elemental parts the organs are built up anew. One essential difference from the development of the embryo only remains, that at no time are all the inner organs wanting. External activity and decay occur simultaneously. But any internal or external movements are wanting; sense organs and nerves are wanting, and there can be truly said to be no outward impressions received, though an activity may be ascribed to the central parts of the nervous system. Yet a regular flow of fluids does not occur, and the only relative physiological action is that of breathing, *which here goes on as passively as in the egg;* in the one case through the stigmata and tracheæ, in the other by the pores of the egg-shell. An active breathing process, such as goes on in the perfect state, is entirely wanting.

While the decay of the inner organs is going on, or has already taken place, the formative elements begin to develop themselves out of the cell-mass; fat nuclei, fat globules, and flakes of stearine unite into round masses of nucleated spheres, which are capable of building up a membrane around themselves, and embracing a nucleus within. Already in the third, still more in the course of the fourth, day do the appendages of the thorax grow in length, and all arise from a thin cellulose skin, and out of a larval cavity which fills up with fat globules and nuclei as the fat body gradually breaks up. With this begins the metamorphosis of the appendages and of the external form of the body into their definitive form; the period of formation of the body of the pupa has ended, and now begins the *period of development of the same.* It lasts from the fifth day to the time of exclusion of the fly, and can, as has already been shown above, be divided into two subdivisions, of which the first reaches to the end of the seventh day.

First to be noticed is the formation of the pupa-case, which, however, was in existence at the end of the first period, but lies as the cuticula right on the cellular skin (zellenrinde) by which it was ensheathed. It now rises up and a space filled with clear liquid separates it from the upper surface of the body. The cellular tegument (zellenrinde) of the appendages is thickened, partly by the increase of the cells present, which seem to receive their plastic material by endosmose, but partly through a free formation of new cells by a self division of the nuclei. The whole cavity of the limbs seem to be compactly filled with nuclei which are uniformly from the outer to the innermost transformed into cells.

By the fifth day the last tarsal joint is divided into two lobes, and show the first position of the claws. On the sixth the sutures are more distinct, the pulvilli are formed, and on the seventh day the external form of the limb is completed. The hypodermis divides into two layers whose deeper portion is disposed on the upper surface of the skin and form the hairs and bristles. Inside the limbs only the position of the nerves and tracheæ of the pupa is established, the muscles arise afterwards.

In like manner the wings are formed, their veins arise, the hairs appear; they attain their definitive form and are folded together.

The halteres grow out, and instead of a single hollow, stunted projection, they are completely formed, and hairy, though still colorless. The antennæ also reach the same grade of perfection, and like the appendages, the segments themselves now assume their definite form. The four abdominal segments are formed out of the eight larval segments which originally formed the abdomen of the fly.

While the external form of the body rapidly advances in this manner to its final perfection, corresponding but slower changes are discovered in the viscera. The fatty tissues continually disappear, and as often the cavity of the body is filled more compactly with nucleolated cells, and fat molecules. The newly formed thin œsophagus thickens at the end towards the proventriculus, and indeed the first beginnings of the sucking stomach is indicated at this period. The chyle-stomach gradually changes in length, its walls are transparent and clear, and it is strikingly demarked from the dark small intestine rendered so by the walls filled with fat corpuscles. With this begins the period of decay, and it reaches on the seventh day its complete development.

Already during the course of seven days usually begins the *second subdivision of the second period* which is characterized by the relative position and development of all the organs of the imago. On the seventh day we find in the cavity of the thorax the first trace of the muscles of the wing. Series of cells of the greatest fineness pass in determinate directions through the liquid masses of fat, and up to the fourteenth day increase in thickness, until finally they lie close together to the lateral spaces of the thorax, and only leave in the median line a slight space for the free passage of the stomach. Their structure is, then, usually definitive, it is a sarcolemmous sheath filled with contracted fibres which lie together in fascicles, and are kept separate from one another by nucleated columns. Meanwhile out of the fragments of the old intestinal canal appears the new, and shortly after this is accomplished there is a union of the small intestine and rectum, and by the tenth day the rectal pouch is placed in relation with the four rectal apillæ. At the same time a new plexus of muscles begins to form on the upper side of the entire intestinal tract.

Still the most important steps in the formation of the principal organs of sense of the fly, the compound eyes, fall into this last section of its developmental history. The ocular disks, which originated out of the hinder division of the brain-appendage, is still connected with the bulb at the beginning of the second period by means of a slender nerve. The bulb gradually extends itself so that it covers the whole interior of the eye-disk, and only becomes separated from it by a thin layer of fat, which has already arisen between the two parts. The bulb shows radiating streaks, which are indications of the nervous threads passing through it. Only out of the eye-disks will the true eyes be formed, *i. e.*, the compartments with the dioptric apparatus, and the perceptive nervous elements. On the twelth day, however, the disks and also each compartment leading out of it, have the very small diameter of 0·051 ^{mm}., which is gradually at the close of the pupa state enlarged five times, while at the same time the cellular elements lying behind each corneous facet, forms for each chamber a crystalline body, a nervous thread and cortical substance. The pigment layer begins to form and is finished, and the bulb sends out the ganglion cells at the base of the chambers of the eye. The nervous centres also take on their last definite form, the hinder part of the ventral cord, which already in the first period had extended out from the infra-œsophageal ganglion, and had extended back into the abdomen, now unites with the thoracic knot. A similar longitudinal commissure unites it with the infra-œsophageal ganglion. At the last moment the central portions send out nerves to the sides into the thoracic muscles and into the limbs, in which during the tenth and eleventh day the muscles begin to form, and afterwards hindwards into the abdomen.

Of the larval organs only the dorsal vessel is destined to pass over into the last division of the developmental period, but it still suffers a total transformation. A process of fatty degeneration similar to that which took place in the alimentary canal occurs, and on the 12th day it assumes a new form and organization. Meanwhile it is not capable of performing its functions, as the want of a histologically perfect system of muscles proves.

The tracheary system is completed last of all. The first positive condition is assumed on the 15th day, and by the 17th it is generally entirely formed. The trunks arise for the most part by means of the masses of nuclei out of the originally solid series of cells, the terminal branches of the organ out of a single cell; the hollow space between them will form the cavity of the trachea, while they branch out by growing outwards. Yet these cells may for the most part be traced back to the masses of nuclei, but soon and especially within the inner of the bundles of primitive muscles of the thorax, *they arise from an organization of the histological formative elements at hand, i.e. the muscular nuclei.* This remarkable fact does not take place without a reaction in the muscular fasciculæ themselves; their sarcolemma disappears and they deteriorate into fascicles of tracheæ wanting the spiral thread.

All the organs which have tracheæ intimately connected with them have the same developed in the last three days. The tracheæ grow out in the nervous centres, in the bulb of the eyes, and the alimentary canal in its entire course is surrounded by a net work of them. They are sent to the rectal papillæ in great abundance and with a peculiar development. The dorsal vessel also and the entire muscular system receives tracheæ and likewise the genital cavities with their outlets and accessory apparatus.

As the development of the genital glands has already begun during the larval state, so during all the pupa state it steadily goes on, the copulatory pouch, the accessory glands, and *receptaculum seminis*, are developed with the new alimentary canal in the last section of the period of development. The genital glands of the male only attain their development during the pupal state. The eggs are developed directly after the exclusion of the fly.

The final perfection of the external form is the coloring of the chitinous skin. Shortly after, on the 18th to 20th day, follows the hatching of the egg.

ADDRESS OF PROFESSOR JOSEPH LOVERING.*

Gentlemen and Ladies of the American Association for the Advancement of Science:—

When the States General of France were assembled for the last time at Versailles, after a long interval of inactivity, and an inaugural address was pronounced by the Bishop of Nancy, Mirabeau passed upon his performance the sweeping criticism that he had missed the grandest opportunity ever offered to man for saying something or holding his tongue. And, whenever this Association, comprising not only those who teach, but many who create science, assembles, as it now does, to listen to the address of its retiring President, if he is duly sensible of his responsibility, he would gladly avail himself of Mirabeau's alternative, either of being equal to the occasion or of being silent. But the rule of the Association, adopted in the original draft of the constitution at Philadelphia, and the example of my predecessors which I am unwilling to reverse, leave me no choice; and when I see around me, not the terrible monsters of the French revolution, maddened by the miseries of a downtrodden country, but calm and high-minded lovers of truth, I feel sure of a just and generous criticism. Welcome, then, the precious opportunity, enjoyed by the President of this Association, of discussing some of the great themes of science before an audience which has for its nucleus the original investigators, discoverers, and inventors in the country, and which like the sun, is surrounded by an extensive chromosphere only a little less brilliant than the central body by contrast; and let my earnest endeavor be not to abuse or waste the great privilege.

---

* The retiring President of the American Association for the Advancement of Science, delivered at the Hartford meeting.

I am confronted on the very threshold of my address by the doubt whether it were better to beat out the little bit of golden thought, for which I have time and capacity, into a thin leaf which shall merely gild the whole vast surface of scientific investigation, even for a single year, or to condense it into a solid though minute globule, only big enough and bright enough to light up some narrow specialty. The general practice which prevails, of selecting a President alternately from the two principal sections into which the Association is divided, will justify me in paying my particular addresses to the physical sciences, knowing that the large and active department of Natural History will be properly treated in its turn by those most competent to do it. Not even the capacious mind of a Goethe, a Humboldt, a Whewell, or a Herbert Spencer is large enough to give a decent shelter to all the subjects which come within the scope of this Association. At the same time I must say that I sympathize with the remarks made by President Hunt at Indianapolis, when he questioned the propriety of excluding geology from the ranks of the physical sciences; only I would give them a still wider significance. Physical science is distinguished from natural history not so much by its subjects as its methods. In my imagination I can picture to myself all these subjects as being handled in the same masterly grasp of mechanics and mathematics by which the physical astronomer holds in his hands the history and the destiny of the solar system. What is only a dream or a fancy now may become a reality to the science of the future. Why, asked Cuvier, may not natural history some day have its Newton: to whom the laws of circulation of the sap and the blood will be only as the laws of Kepler. With such an endorser, I may venture to quote these words of a consummate mathematician without fear of their being cast aside by the naturalists as one of Bacon's Idols of the Tribe. "An intelligence which at any given instant should know all the forces by which nature is urged and the respective situations of the beings of which nature is composed, if, moreover, it were sufficiently comprehensive to subject these data to calculation, would include in the same formula the movements of the largest bodies of the universe and those of the slightest atom. Nothing would be uncertain to such an intelligence, and the future no less than the past would be present to its eyes." The time has already come when a knowledge of physical laws and familiarity with the instruments of physical research are indispensable to the naturalist. I would not recommend that dissipation of intellectual energy, which will make a man superficial in all the sciences but profound in none. But Helmholtz has established, by his own example, the possibility of being an eminent physiologist and, at the same time, standing in the front rank of physicists and mathematicians. The restlessness of human inquiry will never be satisfied with knowing what things are, until it has also discovered how and why they are, and until all the relations of space, time, matter, and force, in all the kingdoms of nature, have been worked out with mathematical precision.

It is a happy circumstance in the history of science, that this vast mechanical problem did not rush upon the mind at once in all its crushing generality. The solar system, with a despotic sun at the centre, competent to overrule all insubordination among planets and comets and check all eccentricities and jealousies, and so far isolated from neighbouring systems as to fear nothing from foreign interferences and entangling alliances, presented a comparatively simple problem: and yet the skill and labor of many generations of mathematicians have not yet closed up the argument upon this first case. On the orbits of this domestic system they have been sharpening their tools for higher and more delicate work. The motions of binary stars have also been brought under dynamical laws, and partially subjected to the rule of gravitation, so far as the astronomer can judge from the best observations which he can make upon those remote objects. But when he launches out, with his instruments and his formulas, into clusters of stars, even those of greatest symmetry, he is wholly at sea, without chart or compass or lighthouse, and with no other illumination than that which comes from a prophetic demonstration in Newton's Principia. The mathematician has here to treat, not with an unlimited monarchy, as in the solar system, but with a republic of equal stars, and the dynamical condition of the clusters is involved in all the obscurity of molecular mechanics; for it matters not whether the individual members of a system are atoms or worlds, if the intervening spaces have corresponding magnitudes. Even in astronomy, the inspiration of mechanics and the pride of mathematics, how trifling is the region which has been subjugated to the rigid rules of the exact sciences when compared with the immense territories which remain under the jurisdiction of natural history, and must be studied, if at all, by the methods of the naturalist, though with an inverted microscope.

If now we circumscribe our outlook by the line which marks where physical science ends and natural history begins, it will be possible to examine only a few of the salient points in the prospect before us: and what these are will depend upon the point of view which we select. Whewell presents the history of any science at each of its successive epochs as circulating around one powerful mind, which figures as the hero of the drama: and whatever immediately precedes or follows is only the prelude or the closing strain to the great movement. In the philosophy of Comte, every science passes through a theological and metaphysical crisis before it reaches the healthy condition of positive knowledge, and its whole history is written out by him in these three acts. With Buckle, the progress of science, without which there could be no history, is coincident with the advance in civilization; but the action begins with science, and the reaction only comes from external causes. All that science and civilization demand is perfect freedom of thought. The worst enemy of both is the protective spirit in church and state, the former telling men what they must believe, the latter what they must do.

Each of these views of scientific development may be true but not to the exclusion of all others. Metaphysical blindness or theological prejudice may block the way of science or defame its fair name. It has been stated that six members of the ultraclerical party at Versailles voted against the appropriation for securing observations of the approaching transit of Venus, because they did not believe in the Copernican system, and this too while the echoes of the celebration of the four hundredth birth-day of Copernicus are still resounding over the earth. So also, circumstances and even accidents may shape the course of discovery: the happiest of all accidents, however, being the appearance on the stage of the discoverer himself.

The point of view which I have chosen for reviewing the close and advancing columns of the physical sciences is this:—Are there any improvements in the weapons of attack, or have any additions been made to them? These are of two kinds:—1. Instruments for experiment, and 2. The logic of mathematics. These are the lighter and the heavier artillery in this peaceful service.

If we cast a hurried glance over that long period of experimental research which began with Galileo and ended with Davy, we recognize, as the chief instrumentalities by which physical science has been promoted, the telescope, the microscope, the pendulum, the balance, and the voltaic battery. It is not necessary for me to enlarge upon the strength and accuracy which the battery and the balance have given to chemistry, or on the stretch and precision of vision which the telescope and microscope have bestowed on astronomy and physics. These instruments, the veterans of many a hard fought battle, science still enjoys: not superannuated by their long service but continually growing in power and usefulness. The little opera-glass with which Galileo first lifted the veil from the skies and awoke the thunders of the Vatican has blossomed out into the magnificent refractors of Cambridge, Chicago, and Washington. The little reflector with which Newton, by a happy mistake, expected to supplant the lens, has grown into the colossal telescopes of Herschel, Rosse, and the Melbourne observatory. The spasmodic, momentary action of Davy's batteries, sufficient, however, to inaugurate a new era in chemistry, has been superseded by constant currents, which grumble not at ten hours a day. After lighting up the forelands of a continent during the night they are fresh to work an ocean telegraph the next morning. With all my wonder at this mysterious instrument which serves so faithfully the cause of science and civilization, with renewed admiration of the microscope and the telescope, one of which transforms an invisible speck of matter into a universe and the other collects the immensity of the heavens into a little celestial globe upon the retina of the eye, I must pause for a moment to eulogize that simplest and most modest of scientific tools, the pendulum.

With the eye of science Galileo saw in the leaning Campanile at Pisa, not a freak of architecture, but the opportunity of experimenting on the laws of falling bodies: and, in the adjacent cathedral where others admired the marble pavement or the vaulted roof, the columns, statues, or paintings, his attention was caught by the isochronous vibrations of the chandelier, which during the long centuries has never been absolutely at rest. When it is said that the pendulum has no rival as a standard of length except the metre, that it furnishes an exact measure of time, and that time is an indispensable element in the study of all motion, and also the most available means of obtaining longitude on the earth and right ascension in the heavens, a strong case has been made out for the practical and scientific usefulness of Galileo's discovery. During the long years of doubt in regard to the true figure of the earth, the pendulum maintained the cause of Newton in opposition to the erroneous reports of the geodesists, until Maupertuis, by a new measurement, flattened, as has been pithily said, the earth and the Cassinis at the same time. The shape, rotation, and density of the earth; the diminution of terrestrial gravity with an increase of distance from the centre; the local attractions of mountains, and secrets hidden below the surface of the planet, have been discovered or verified by the declarations of the pendulum: which, whether in motion or at rest, has never tired of serving science. And, in a wider sense, the pendulum has done for the electric and magnetic forces what, in its restricted meaning, it did for gravity. That which Borda failed of accomplishing in the measurement of arcs the pendulum realizes in its measurement of time: it multiplies its observations, eliminates its own errors, strikes its own average, and presents to science the perfect result. In 1851, a crowd of spectators was assembled in the Pantheon of Paris to witness the first performance by the pendulum of the new part prepared for it by Foucault: in which, obedient to its own inertia, and indifferent to the earth's rotation, it preserves the parallelism of its motion: an experiment startling though not wholly unanticipated, and which has made the circuit of the earth. The new contrivance of Zöllner promises to indicate changes in the direction of a force as accurately as the common pendulum measures intensity.

Let us now consider what the physicists of our own day, and their immediate predecessors, have added to their rich inheritance of instrumental means, remembering all the time that, however impressive from their novelty these additions may be, and however manifold their applications, they have only supplemented the experimental methods which have been described without supplanting them. For the most part, the later devices would be useless without the coöperation of the earlier ones.

An interesting event in the history of science, which must be known to many of you, has taken place during the current year. In 1824, Poggendorff began to edit the *Annalen der Chemie und der Physik*. Under his supervision 150 volumes have been issued, containing 8,850 distinct communications from 2,167 different authors, the 193 papers of H. Rose outnumbering those of any other contributor. The history of physical and chemical discovery during the last fifty years might be written out of the materials treasured up in this single journal. In recognition of the signal service which Poggendorff has hereby rendered to science, his friends assumed the editorship of one volume in 1874, which is called the Jubilee volume [Jubelband].

In 1826, Poggendorff described in volume vii. of his journal a device of his own invention for observing with exceeding nicety the movements of a magnetized bar. A mirror was attached to the bar and moved with it. From this mirror a beam of light was reflected into a theodolite. This was the origin of the happy thought of amplifying a trifling motion by making the finger of a long and delicate ray of light serve as a weightless pointer. A few years later, this idea was embodied by the mathematician, Gauss, in an instrument which he called the magnetometer. Since that time, it has been continually budding out in new applications, scientific and practical. I need only recall to your recollection the beautiful method of Lissajous for compounding the vibrations of tuning-forks, and tracing in golden lines the curves which are characteristic of different musical intervals and varied phases of vibration. A new chapter has been opened in mechanics for describing and explaining these strange and nameless curves; and, in acoustics, the ear has been dispossessed by the eye of what would seem to be its own by right divine, and it is no longer the best scientific judge of sounds. By new devices Koenig has translated time into space and made visible the individual vibrations of the invisible air; and, in numerous ways, the mechanism of sound is as real to the eye as the sensation is to the ear.

With a bare allusion to the fact that every message which passes over the cable telegraph is a tribute of indebtedness to the simple but comprehensive method of Poggendorff, I pass to two other cases of great difficulty and wide significance in which the same method has triumphed. I refer to the determination of the velocity of electricity and the velocity of light.

When Wheatstone devised and executed the ingenious experiment of producing three electrical sparks, not strictly at the same instant, but after the brief interval required by electricity to travel over one quarter of a mile of copper wire, and then of observing, not the sparks themselves, but their images, as seen in a mirror revolving with the prodigious velocity of 800 turns in a single second, and from the prolongation and relative displacement of these images deducing the velocity of electricity, the duration of the electrical light, and the duality in the direction of the transmitted disturbance, he delighted the brotherhood of science by the skill and boldness of his attempt and astonished it by the extravagance of his results. For twenty years no one ventured to repeat the difficult experiment. When at length it was tried by Feddersen, and more recently by our own associate, Rood, the values which they assigned to the duration of the electrical light, and which could not be challenged, made still the wonder grow. So far as this mode of experimenting concerns the velocity of electricity, Wheatstone stands alone: and his estimate of this velocity (the largest known velocity in the universe unless we count in the velocity of gravitation) has never been brought to a second trial. Indirectly, it has been tested by some of the operations conducted upon land and ocean lines of telegraph. When the local times of two places are compared by means of electro-magnetic signals, sent alternately in opposite directions, the difference of longitude and the transmission-time of electricity can be disentangled from one another, by the strategy of mathematics, and the most probable value computed for each. The velocity which has been calculated from these longitude-campaigns falls far below that credited to Wheatstone. The apparent discrepancy is explained by a misinterpretation of Wheatstone's experiment. An experiment which proves that electricity runs through one quarter of a mile of wire *at the rate* of 288,000 miles a second does not justify the inference that it would move over 288,000 miles in one second. Anomalous as the case may be, electricity has no velocity in the ordinary sense. The transmission time of the electrical disturbance is proportioned to the square of the distance to be travelled. Therefore, the velocity has no constant fixed value, but varies with the length of the journey. This law, which is deduced from the mathematical theory of Ohm, introduces order among the experiments where, otherwise, there would be chaos. It is not surprising that Wheatstone and the readers whom he addressed were misled by the original facts. Few men, who have rendered signal services to science, and who have finally reached the highest pinnacle of fame, have suffered more from poverty and neglect, and waited longer for a recognition of their merits, than the modest student of Nuremberg. The slender volume which will perpetuate his name was indeed published at Berlin in 1827, and antedates Wheatstone's experiment by seven years. But the book was treated with contempt by a minister of state, to whom Ohm presented a copy, at his university of Cologne, and was first brought to the notice of English readers in 1841, when an English translation of it was effected through the agency of the British Association, and the Copley medal was presented to Ohm by the Royal Society of London. As late as 1860, when the same work was rendered into French, the translator admits that the mathematical theory of Ohm on the galvanic circuit, the elements of which have since rapidly circulated in popular text-books, was almost unknown in France, that high seat of science. If the serene but steady light of mathematics had not been dimmed by the blaze of experimental successes, and the teachings of Ohm had been heeded sooner, the science of electricity would have been the gainer, and the men of science would have been saved the mortification of treating the electromagnetic telegraph as an impracticability.

When Wheatstone was a candidate to fill a vacancy among the corresponding members of the French Institute, it was objected that he had only made a brilliant experiment, but had not discovered a new principle. Arago came to his rescue and asserted that he had introduced a powerful and fertile method of experimentation which would be felt in other sciences besides electricity. The French physicist lost no time in devising means for making good these claims. If it could be proved experimentally that the velocity of light was greater in air than in water a capital fact in the contending theories of light would be settled forever. Arago planned the experiment and pressed its feasibility upon the Academy of Sciences with all the power and eloquence of his nature. At last he roused two younger physicists to undertake what his growing infirmities prevented him from doing with his own hands. The result declared in favor of undulations, and a fatal blow was dealt to the corpuscular theory of light which had vexed science since the days of Newton. If Fizeau and Foucault drew their inspiration from Arago, they owed their success to nothing except their own skill in devising and executing. Having tried the temper of their steel on this easier problem, they were ready for the grand attack, which was to measure the absolute velocity of light.

The instrumental arrangements of these two experimentalists agreed only in the part which each borrowed from Poggendorff: the details differed so widely as to give to whatever agreement might appear in their results the force of an irresistible argument for their accuracy. The velocity of light, as found by Fizeau in 1849 by the artificial eclipses which the teeth of his revolving wheel produced, exceeds by about six per cent. the velocity which Foucault obtained, in 1862, with the moving mirror. The arithmetical mean of the two values comes very close to the astronomer's estimate of the velocity of light. But this simple average is precluded unless it can be proved that the two experiments are entitled to equal weight. The internal evidence, expressed by what mathematicians call the probable error, manifested a decisive preference for Foucault's result, and it has met with general acceptance. The soundness of the scientific judgment in this case has been placed beyond all cavil by Cornu, who has recently repeated Fizeau's experiment, with additional precautions, and resolved the discord into a marvellous accord. Fizeau's experiment, in spite of the numerical defect, was hailed as one of the grandest triumphs of experimental skill. In 1856, he received the prize of 30,000 francs which the Emperor of the French had founded, to be given for the work or the discovery, which, in the opinion of the five academies of the Institute, had conferred the greatest honor and service upon the nation. Hitherto, it had been supposed that nothing short of an interstellar or an interplanetary space was a match for the enormous velocity of light. And yet one physicist, by using a distance of less than six miles, and another, without going outside of his laboratory, have discovered what astronomers had searched heaven and earth to find out.

By these capital experiments the science of optics has achieved its own independence. Let us see what they have done, at the same time, for astronomy. The sequences in the eclipses of Jupiter's moons are modified by the velocity of light. The aberration of starlight is a measure of the ratio between the velocity of light and the velocity of the earth. For nearly two centuries our knowledge of the velocity of light leaned upon one or the other of these relations. If the velocity of light can be known from experiment, the problem may be reversed and the distance of the sun given to the astronomer. As soon at it appeared that Foucault's estimate of the velocity of light fell short of the astronomical valuation by about three per cent, it was certain that either the experiment was in error, or the received aberration was too small, or the reputed distance of the sun was too large. An error of three per cent. in the experiment or in the aberration was inadmissible. But it was conceivable that the distance of the sun should be at fault, even to this extent. The popular announcement that Foucault had picked a flaw in the astronomer's work was not correct. Astronomers had always known what those who pinned their scientific faith on text-books did not expect: that the problem of finding the sun's distance was an exceedingly delicate case, and that an ominous cloud of uncertainty hung over their wisest conclusions. Whenever it is possible to interrogate nature in more ways than one, science is not satisfied with a single answer, nor with all the answers unless they agree. The transit of Venus, the parallax of Mars, and the tables of the Moon, each can tell the sun's distance. But their testimony was contradictory, and neither one at all times repeated the same story. The question was, which to believe. Since 1824, when Encke published his exhaustive computations on the last transits of Venus, the distance which they assigned to the sun has been acquiesced in as the most probable. But the moon, as has been said, has always been a thorn in the sides of mathematicians. While practical and theoretical astronomers have been reducing its motions to stricter discipline, the suspicion has been steadily gaining strength in their minds that the distance adopted from the transits was too large. The effect of Foucault's experiment was to intensify the doubt. The case of the twin transits of the last century, thought to have been closed forever by Encke, has recently been opened again by the astronomer Stone. When Venus has nearly entered upon the sun, the moment of interior contact is preluded by the formation of a slender ligature (called the black drop) between the nearest parts of the two discs; caused, perhaps, by irradiation. One observer has recorded the time when this ligature began, another the time when it was broken. In working up the observations of the last transits, both classes were not combined indiscriminately. Mr. Stone has reëxamined the documents, classified differently the materials, and extracted from them two new and independent values for the sun's parallax. The reconciliation which he has suddenly brought about between the experiments of Cornu and Foucault, the motions of the moon, and the transits of Venus, is as perfect as it is surprising. Nevertheless, the approaching transits of Venus, the earliest of which is close upon us, will be welcomed, if not as the only possible way of solving a hard problem, at least for the confirmation which is demanded by a solution already reached: for able astronomers have dissented from the interpretation put upon the records by Stone. The minds of observers have been prepared for what their eyes are to see, in December, 1874, by the experimental rehearsal of the black drop, and the photographer's box will arrest the planet in the very act.

The consequences of Foucault's experiment, substantiated as it may be by the best astronomical evidence, are as far reaching as the remotest stars and nebulæ. The sun's distance is the astronomer's metre, through which masses, diameters, and distances are proportioned out to planets, comets, and stars. If the sun's distance is cut down by three per cent., there must be a general contraction in all the physical constants of the universe. The earth only is immediately exempt from this liability. But if, as modern science teaches, the earth lives only by the triple radiation from the sun, then an earlier doom has been written for the earth also. Geology is no longer allowed to cut its garment from a past duration of unlimited extent. The numerical estimates of physical science, with a large margin of uncertainty, assign limits between which alone geology has free play. Whatever tends to reduce or enlarge those limits must be of interest to the geologist as well as to the astronomer.

This is the brilliant career, in electricity, optics, astronomy, and geology, of the little mirror, cradled in the laboratory of Poggendorff, and which has not yet seen its fiftieth birthday.

In making this exhibit of the instrumental appliances of modern physics, I will simply name the polariscope, the stereoscope, and the instruments in photography, and hurry on to the spectroscope.

The steps by which the spectroscope has attained its preëminent rank among the instruments of the physicist and the astronomer were taken at long intervals. A whole century intervened between Newton's experiments with the prism and Wollaston's improvement. The substitution of a long and narrow slit for the round hole in the window shutter was enough to reveal the presence of the two boldest dark lines in the solar spectrum. Wollaston stood on the threshold of a rich development in science, but neither he nor his compeers were ready for it, and what he saw, novel as it was, attracted little attention. Spectrum analysis, in relation to light itself, began when Frauenhofer published, in 1817, in the memoirs of the Bavarian Academy, an account of his experiments on the direct and reflected rays of the sun, on starlight, and various artificial sources of light: dispersing the rays by prisms of fine Munich glass and then receiving them into a theodolite. Frauenhofer repeated some of his experiments in the presence of the younger Herschel, but for many years he had the field wholly to himself. A paper by Herschel on the colors of artificial flames acquires a new interest from what has been done more recently. Between 1830 and 1860, numerous physicists, among whom are the well known names of Brewster, Miller, Wheatstone, Powell, Stokes, Gladstone, Becquerel, Masson, Van der Willigen, Plücker, and Angström, were at work upon the facts connected with the emission of light by incandescent bodies and its absorption by gases and vapors. As early as 1830, Simms had placed a lens in front of the prism, with the slit in the focus, and another lens behind the prism to form an image of the slit.

The first hint of that pregnant fact, the reversal of the bright spectrum bands of flames, came from Foucault in 1849. His experiment was repeated at Paris, in 1850, in the presence of Sir William Thomson. It was reserved for a young physicist of Heidelberg, who was not born until seven years after Frauenhofer laid the foundations, to place the keystone upon the structure on which many hands had labored: by demonstrating, in 1860, the law which is the theoretical basis of the chemistry of the heavens. Kirchhoff, with admirable frankness, is careful to say that this law had been anticipated by others, especially by Angström and Balfour Stewart, although it had not been sharply stated or severely proved. It is a singular fact that the mechanical explanation of the law, as it has been expounded by Kirchhoff, Angström, and Stokes, was partially enunciated one hundred years ago by the mathematician, Euler, when he said that every substance absorbs light of the special wave-length which corresponds to the vibration of its smallest particles. The 11th of July, 1861, will be ever memorable in the history of science as being the day on which Magnus read, before the Berlin Academy, Kirchhoff's memoir on the chemical constitution of the sun's atmosphere, and the existence in it of familiar substances found upon the earth. Speedily, spectroscopes were multiplied, modified, and improved, and became indispensable auxiliaries in the workshop, the laboratory, and the observatory. It is not necessary to enlarge upon what this instrument has done for common chemistry, in hunting out the minutest traces of common substances and detecting new ones. The physician, the physiologist, the zoölogist, the botanist, and the technologist have shared with the chemist and the physicist the services of this powerful analyst. But it is the highest prerogative of the spectroscope to be able to make a chemical analysis of celestial bodies, upon the single condition that they give to it their light. Polarization can only say whether any portion of this light is reflected. The motions which the telescope uncovers may decide in favor of a central attraction, but it is silent as to the intensity of this attraction unless the moving body belongs to the solar system. The universality of a gravitation may be proved, but not the universality of the very gravitation which pervades our own system; except by an argument from analogy. We see that one star differs from another star in glory. But what the other differences or resemblances are we know not, without the spectroscope. Henceforth astronomy possesses a new instrument of discovery, and also a new tribunal to which all speculations about the sun and the stars, the aurora and the zodiacal light, the meteors and the comets, must be brought and by which they must be judged.

I leave it to the naturalists to assign a value to the alleged anticipations of Darwin by the geometer Maupertuis, who was said to have died just before he was going to make monkeys talk. The whims and conceit of Lord Monboddo are not worthy of notice. Lamarck began life as a soldier: was a meteorologist as far and as long as Napoleon would allow him to be: perhaps he was a botanist from choice, but he was made a zoölogist, in spite of himself, by the revolutionary Convention. He was as brave in science as in war; but he expected to *create* it, by a simple effort of thought. Having demolished the modern chemistry, he turned his iconoclastic zeal into natural history. His philosophy of zoölogy was published a few years after the cosmogony of Laplace; in which the mathematician broaches the theory of evolution as a mechanical doctrine, capable of explaining certain characteristics of the solar system, about which the law of gravitation is silent. Whoever reads the stately chapters of Laplace, on the stability of the planets and the safeguards of the comets, will easily recognize expressions which are the mechanical equivalents of the principles of natural selection and the survival of the fittest. The elder Herschel hazarded the speculation, that the clusters of stars and the nebulæ which his devouring telescope had picked up, by hundreds, on the verge of the visible heavens, were genuine suns assembled under the organizing power of gravitation; and that the varieties in size, shape, and texture, were produced by differences of age and distance. The imagination of Herschel and other astronomers has taken a loftier flight. To them many of the nebulæ are not clusters of stars, but unborn solar systems, waiting for that consolidation by which planets are evolved and a central sun is formed, and destined thus to repeat the cosmogony of the home system. Comte claims that he has raised the nebular hypothesis to the rank of positive science. He supposes the stupendous enginery of evolution to be reversed. He follows, with his mathematics, the expanding sun backwards into chaos, until it has absorbed into its bosom even the first born among the planets, and finds, at every stage, numerical confirmation of what Laplace threw out as a plausible conjecture. As Mr. Mill and other writers of note have accepted this authority, it should be understood that Comte has never published the data or the process of his computations. By whatever other inspiration he arrived at his conclusion, he was not brought to it by his mathematics. He has said all that is necessary to show that he ignored all the difficulties of the problem, and dodged the only solution that could give satisfaction. The cosmogony of Laplace, with all its fascination, must be excluded from exact mechanics and remanded back to its original place in natural history, by the side of the more general nebular hypothesis of Herschel. All other cosmogonies which poetry or science have invented are childish in comparison with this: and no one would desire to banish it from science altogether, until it is disproved or displaced by something better. Instead of *deciding*, it must *share* the fate of the all-embracing cosmical speculation of Halley. How uncertain that fate is we may be taught by the frequency with which the preponderance of evidence has shifted from one side to the other, during the last fifty years. The irresolvability of many of the nebulæ, by powerful telescopes, led Herschel to espouse the cause of a diffuse primeval matter, out of which worlds were fashioned. No wonder that, in particular cases, the negative evidence was sometimes turned into positive evidence on the other side, by improvements in telescopes. Although every nebula which deserted from the nebular hypothesis strengthened the suspicion that the remaining irresolvability was purely optical, a sufficient amount of negative evidence would probably have always existed to create more than a doubt in the minds of many astronomers. On the discovery of spectrum analysis, observers rallied around it, in the hope of finding an escape from the dilemma: and this new hope has not been disappointed. The continuous spectra of some nebulæ prove them to be suns, enveloped in more or less of atmosphere. The broken spectra of other nebulæ show that they are in the condition of an incandescent gas. The classification which the spectroscope makes of the nebulæ corresponds so well with their telescopic appearance as to justify the confidence which one class of astronomers had in their way of deciding on the truth of the nebular hypothesis. While the spectroscope has manifested varieties of material, color, temperature, and consolidation in nebulæ and stars, both single and composite, beyond anything which the perfected telescope could ever have revealed, it has at the same time found enough of earth in all of them to make man feel at home any where in the visible universe. The fact that certain well-known substances on this planet pass current everywhere in nature leads irresistibly to the conclusion that all the specimens came originally from the same mint. It is the legitimate office of science to reduce the more complex to the simple: to explain, if possible, the existing state of matter by an anterior state. The nebular hypothesis, which attempts to do this, no longer starts from a conjecture but a reality: *viz.*, the existence of diffused incandescent vapor; and science will hold on to it, until a better theory of mechanical development is found.— *Concluded in next number.*

REVIEWS AND BOOK NOTICES.

The Principles of Science.*—Though each scientist, whether consciously or not, does his work on principles underlying all useful and durable efforts, yet the methods have been gradually developed, and the laborer in one department may be ignorant of the mode of procedure in others quite remote from his line of study. The author discusses the methods common to all the sciences, though with a bias towards physical science, particularly physics, chemistry and astronomy. As a result we have a book which we are sure will win the sympathy of the reader, as it is an earnest and sensible treatise. Wherever we have opened the volume we have been attracted by the interest and clearness of the style, and the general tone of the discussion which, though on the whole conservative, is in full accordance with the spirit of modern science.

The chapters on the use of hypothesis, and the character of the experimentalist are capital. Professor Jevons boldly says "it is wholly a mistake to say that modern science is the result of the Baconian philosophy; it is the Newtonian philosophy and the Newtonian method which have led to all the great triumphs of physical science, and I repeat that the 'Principia' forms the true 'Novum Organum.'" If we mistake not, the theory of evolution, as suggested by Lamarck, Spencer, Darwin and others is a result of the Newtonian rather than the Baconian method; certainly it may be said in its present stage to be a "hypothetical anticipation of nature," valuable as it is as a means of research.

In the chapter on Classification the author states his belief that a natural classification is an "arrangement which would display the genealogical descent of every form from the original life germ. Those morphological resemblances upon which the classification of living beings is almost always based are inherited resemblances, and it is evident that descendants will usually resemble their parents and each other in a great many points." Much importance is given to the bifurcate or dichotomic arrangement so universally used in descriptive biology.

---

* The Principles of Science; a treatise on Logic and Scientific Method. By W. Stanley Jevons. Special American Edition, bound in one volume. New York. MacMillan & Co., 1874. 8vo. pp. 480.

How a mind trained in logic and the methods of exact science looks upon the theory of evolution, may be seen from the following extract:—

> "The genealogical view of the mutual relations of animals and plants leads us to discard all notions of any regular progression of living forms, or any theory as to their symmetrical relations. It was at one time a great question whether the ultimate scheme of natural classification would prove to be in a simple line, or a circle, or a combination of circles. Macleay's once celebrated system was a circular one, and each class-circle was composed of five order-circles, each of which was composed again of five tribe-circles, and so on, the subdivision being at each step into five minor circles. Thus he held that in the animal kingdom there were five sub-kingdoms—the Vertebrata, Annulosa, Radiata, Acrita, and Mollusca. Each of these was again divided into five—the Vertebrata consisting of Mammalia, Reptilia, Pisces, Amphibia, and Aves.* It is quite evident that in any such symmetrical system the animals were made to suit themselves to the classes instead of the classes being suited to the animals.
>
> We now perceive that the ultimate system will be an almost infinitely extended genealogical tree, which will be capable of representation by lines on a plane surface of sufficient extent. But there is not the least reason to suppose that this tree will have a symmetrical form. Some branches of it would be immensely developed compared with others. In some cases a form may have propagated itself almost from primeval times with little variation.
>
> In other cases frequent differentiations will have occurred. Strictly speaking, this genealogical tree ought to represent the descent of each individual living form now existing or which has existed. It should be as personal and minute in its detail of relations, as the stemma of the kings of England. We must not assume that any two forms are absolutely and exactly alike, and in any case they are numerically distinct. Every parent then must be represented at the apex of a series of divergent lines, representing the generation of so many children. Any complete and perfect system of classification must regard individuals as the infimæ species. But as in the lower races of animals and plants the differences between individuals are usually very slight, and apparently unimportant, while the numbers of such individuals are immensely great, beyond all possibility of separate treatment, scientific men have always stopped at some convenient but arbitrary point, and have assumed that forms so closely resembling each other as to present no constant difference were all of one kind. They have, in short, fixed their attention entirely upon the main features of family difference. In the genealogical tree which

---

* Swainson, 'Treatise on the Geography and Classification of Animals,' 'Cabinet Cyclopædia,' p. 201.

they have been unconsciously aiming to construct, diverging lines meant races diverging in character, and the purpose of all efforts at so-called natural classification was to trace out the relationships between existing plants or animals. Now it is evident that hereditary descent may have in different cases produced very different results as regards the problem of classification. In some cases the differentiation of characters may have been very frequent, and specimens of all the characters produced may have been transmitted to the present time. A living form will then have, as it were, an almost infinite number of cousins of various degrees, and there will be an immense number of forms finely graduated in their resemblances. Exact and distinct classification will then be almost impossible, and the wisest course will be not to attempt arbitrarily to distinguish forms closely related in nature, but to allow that there exists transitional forms of every degree, to mark out if possible the extreme limits of the family relationship, and perhaps to select the most generalized form, or that which presents the greatest number of close resemblances to others of the family, as the *type* of the whole.

Mr. Darwin, in his most interesting work upon Orchids, points out that the tribe of Malaxeæ are distinguished from Epidendreæ by the absence of a caudicle to the pollinia, but as some of the Malaxeæ have a minute caudicle the division really breaks down in the most essential point.

'This is a misfortune,' he remarks,* 'which every naturalist encounters in attempting to classify a largely developed or so-called natural group, in which, relatively to other groups, there has been little extinction. In order that the naturalist may be enabled to give precise and clear definitions of his divisions, whole ranks of intermediate or gradational forms must have been utterly swept away: if here and there a member of the intermediate ranks has escaped annihilation, it puts an effectual bar to any absolutely distinct definition.'

In other cases a particular plant or animal may perhaps have transmitted its form from generation to generation almost unchanged, or, what comes to the same result, those forms which diverged in character from the parent stock, may have proved unsuitable to their circumstances, and may have perished sooner or later. We shall then find a particular form standing apart from all others, and marked by various distinct characters. Occasionally we may meet with specimens of a race which was formerly far more common but is now undergoing extinction, and is nearly the last of its kind. Thus we may explain the occurrence of exceptional forms such as are found in the Amphioxus. The Equisetaceæ perplex botanists by their want of affinity to other orders of Acrogenous plants. This doubtless indicates that their genealogical connexion with other plants must be sought for in the most distant past ages of geological development.

---

* Darwin, 'Fertilization of Orchids.' p. 159.

Constancy of character, as Mr. Darwin has said,* is what is chiefly valued and sought after by naturalists; that is to say naturalists wish to find some distinct family mark, or group of characters by which they may clearly recognize the relationship of descent between a large group of living forms. It is accordingly a great relief to the mind of the naturalist when he comes upon a definitely marked group, such as the Diatomaceæ, which are clearly separated from their nearest neighbours the Desmidiaceæ by their siliceous framework and the absence of chlorophyll. But we must no longer think that because we fail in detecting constancy of character the fault is in our classificatory sciences. Where gradation of character really exists, we must devote ourselves to defining and registering the degrees and limits of that gradation. The ultimate natural arrangement will often be devoid of strong lines of demarcation.

Let naturalists, too, form their systems of natural classification with all the care they can, yet it will certainly happen from time to time that new and exceptional forms of animals or vegetables will be discovered, and will require the modification of the system. A natural system is directed, as we have seen, to the discovery of empirical laws of correlation, but these laws being purely empirical will frequently be falsified by more extensive investigation. From time to time the notions of naturalists have been greatly widened, especially in the case of Australian animals and plants, by the discovery of unexpected combinations of organs, and such events must often happen in the future. If indeed the time shall come when all the forms of plants are discovered and accurately described, the science of Systematic Botany will then be placed in a new and more favourable position, as remarked by Alphonse Decandolle.†"

From paying too much attention to a classification by types, *i.e.*, by selecting one typical form and grouping around it allied forms, Professor Jevons believes that "a certain laxity of logical method is thus apt to creep in, the only remedy for which will be the frank recognition of the fact that according to the theory of hereditary descent, the gradation of characters is probably the rule, and the precise demarcation between groups the exception."

The author agrees with those naturalists who regard the existence of any such groups as genera and species as "an arbitrary creation of the naturalist's mind;" an important result of the establishment of the theory of evolution being "to explode all notions about the existence of natural groups constituting separate creations." The whole is in his opinion a question of degree.

---

* 'Descent of Man,' vol. I, p. 214.

† 'Laws of Botanical Nomenclature,' p. 16.

What is the outcome of the tendencies of modern scientific thought, materialism and the reign of physical law? The logical and courageous philosopher with the modesty of true science will exclaim with our author, after a survey of the little that is positively known of the laws of nature that "before a rigorous logical scrutiny the Reign of Law will prove to be an unverified hypothesis, the Uniformity of Nature an ambiguous expression, the certainty of our scientific inferences to a great extent a delusion."

The closing paragraphs of the book leave an excellent impression, and its whole tendency is to induce that attitude of the mind which characterizes the true philosopher who, as our author quotes from Faraday, "should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; have no favourite hypothesis; be of no school: and in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature."

SCAMMON'S MARINE MAMMALS OF THE NORTHWESTERN COAST AND AMERICAN WHALE-FISHERY.* —The title of Capt. Scammon's important work indicates sufficiently its object and scope. It is divided into three parts, besides containing a lengthy appendix. Part I (comprising 112 pp.) is devoted to the natural history of the Cetacea, or the whales, porpoises and dolphins. Part II (69 pp.) treats in a similar way of the Pinnipedia, or the seals, while Part III (87 pp.) contains a concise and very interesting history of the American Whale-fishery. In Part I, the author has before him an almost wholly unworked field, and one in which he proves himself to have been an intelligent and faithful laborer. The marine mammals, and especially the Cetacea, from the nature of the element in which they live, as well as their generally unwieldy proportions and wary dispositions, are among the most difficult animals to study that the naturalist encounters. Only a naturalist who combines with his scientific knowledge the experience of a whaleman could even hope to give more than a very inadequate account of the habits of these "monsters of the deep." The immense size of many of the larger Cetacea, and the great infrequency of opportunities of observing them stranded, or wholly removed from the water, render it very difficult to get either accurate figures of them or more than approximate measurements. Capt. Scammon seems to have enjoyed rare opportunities for collecting material for his book, and an excellent preparation for the task he has undertaken, for, besides his twenty years of personal experience and observation, he has availed himself of information acquired by other intelligent whalemen. Hence his biographies, statistics of size, and his figures of the animals are far more satisfactory than anything that has previously appeared treating of the general history of these little known animals. Fourteen pages, for instance, are devoted to the California gray whale (*Rhachianectes glaucus* Cope) in which is detailed not only its habits and distribution, but the methods and dangers of its pursuit and capture; the article being also illustrated with three lithographic plates. The bowhead or great polar whale (*Balæna mysticetus*) receives an equally extended notice, this species being "by far the most valuable in a commercial point of view of all the *Balænidæ* and is the chief object of pursuit by the whaleman in the northern seas." The yield of oil, in large individuals of this species, is said to exceed sometimes two hundred and seventy-five barrels, while the product of baleen may be upwards of three thousand five hundred pounds. The whaling grounds are described at length, as is also what is termed "Bowhead Whaling." Capt. Scammon considers it as conclusively proved that this species passes from the Atlantic to the Pacific, "or rather," as he expresses it, "from the Atlantic Arctic to the Pacific Arctic by the North," and believes that air-holes always exist in the ice which covers the arctic waters, even in the coldest latitudes. About a dozen pages are devoted to the sperm whale (*Physeter macrocephalus*), and about five to the orca, or killer, which is, of all the Cetacea, the most rapacious and terrible to the larger denizens of the sea.

---

* The Marine Mammals of the Northwestern Coast of North America, described and illustrated: together with an account of the American Whale-fishery. By Charles M. Scammon, Captain U. S. Revenue Marine. San Francisco: John H. Carmany & Co. 1874. 4to, 319 pp., with 27 lithographic plates and numerous woodcuts.

In Part II the ground is less new, but here very material contributions are made to a better knowledge of several species of the larger Pinnipeds, especially of the sea elephants, sea lions, and fur seals of the California coast, and also of the sea otter

(*Enhydra marina*), which is singularly included with the Pinnipedia! The history of the wholesale destruction of these animals for commercial purposes possesses a peculiar and rather melancholy interest. Besides adding much new matter to the history of the fur seal as observed by the writer on the California coast, the chapter is made much more complete by the quotation of the greater part of Capt. Bryant's excellent article on the fur seals of Alaska, published a few years since in the Bulletin of the Museum of Comparative Zoology.*

Part III is possibly the most interesting portion to the general reader, giving as it does not only a succinct chronological and statistical history of the American Whale-fishery, but also vividly portraying the privations, dangers, and excitements attending this daring pursuit, as well as the special training, energy and skill necessary to its successful prosecution. New England may well be proud of the names so favorably mentioned as the founders and leaders in this great enterprise, whose vessels were often the first to bear our national emblem to remote waters and distant seaports.

In the appendix is given a systematic "catalogue of the Cetacea of the North Pacific Ocean" by Mr. W. H. Dall, of the U. S. Coast Survey, prepared with special reference to Capt. Scammon's monograph in the preceding pages of the general work. This catalogue embraces also many osteological notes and descriptions of new forms. The list comprises about forty-four species, which Mr. Dall observes, "appear to be more or less thoroughly characterized," but ten are of unknown habitat. "Leaving these out," he adds (with all species based on insufficient material), we have as the approximate distribution of the known Pacific Cetacea: Japan, five species; northern seas, six species, including two or three which visit California; warm seas and South Pacific, eleven species; coast of Western North America, from the Aleutian Islands to Central America, eighteen species, including several visitors from the Arctic Seas."

The volume closes with a "glossary of words and phrases used by whalemen," and a list of the "stores and outfits" usually taken out by a first-class whale-ship for a Cape Horn voyage.

While Capt. Scammon's work is very satisfactory in the fulness with which it deals with external characters — color, size, form, proportions, etc. — and in its biographical details, the author abstains (and perhaps wisely) from a critical discussion of points of synonymy and affinity; yet it is a work that goes far towards filling a wide gap in marine mammalogy, to which subject it is a most welcome and important contribution. The publishers have spared no pains, apparently, to make the work attractive, and the illustrations are generally of a high order of execution. The work is very appropriately inscribed by the author to the memory of Louis Agassiz.—J. A. A.

---

* Vol. II, pp. 95-108, 1870.

BOTANY.

BOTANY OF WILKES' SOUTH PACIFIC EXPLORING EXPEDITION.—Since the lamented death of Dr. Torrey, his report on the Botanical collections made by the naturalist of Wilkes' expedition on our western American coast, has been printed under the care of Prof. Gray. It makes the larger part of the 17th volume of the results of that expedition, of which, like the rest, only 100 copies are printed by Congress. A small number of extra copies have, however, been secured, at private expense; these are bound up with the preceding part of the volume, devoted to the Lower Cryptogamia of the expedition (Lichens, Algæ and Fungi) and the large plates being folded and bound in, the whole makes a stout royal quarto volume, with 29 plates. The Naturalists' Agency has this on sale, at ten dollars. The mosses of the same expedition by Sullivant, which form the first part of this same volume in the government copies, in the extra edition have the letter-press made up into imperial folio pages, in double columns, to match the 26 great folio plates. A very few copies of this handsome volume still remain in the hands of the late Mr. Sullivant's executors, and can be had for ten dollars each.

INFLUENCE OF FORESTS ON THE RAINFALL.—At a recent meeting of the French Academy M. M. Fautra and Sarquiau read a note relative to this subject. They found from experiments made in a forest of more than 500 hectares,* and also on a plain free from trees situated about 300 yards from the forest, that much more rain fell in the wooded part than on the plain.

---

* A hectare is 11,960 English square yards.

ZOOLOGY.

The Snow Goose.—On the 6th of October, 1873, I shot at Mt. Carmel, Illinois, a fine adult male *Anser hyperboreus*, which had been living with a flock of tame geese for nearly a year. The bird had been crippled in the wing the preceding fall, but the wound, which was merely in the muscles, soon healed, and it escaped by flight. It flew about half a mile, and, observing a flock of tame geese upon the grassy "commons" between the town and the river, alighted among them. It continued to stay with them, going home with the flock regularly every evening, to be fed and enclosed in the barn-yard.

My attention was attracted to this bird by its owner, Mr. Thomas Hoskinson, from whom I got the above facts; and who kindly told me that if I would shoot the bird he was willing to have it sacrificed to science. Accordingly, I repaired to the "commons" and found the flock at a locality designated. After some little search the "white brant" was discovered, being distinguished by its black quill-feathers, rather smaller size, shorter neck, black instead of bluish eyes, and the black space along the commissures of the bill. When unmolested this bird was as unmindful of a person as the tame geese, and it required chase to make it endeavor to escape, which it always did by rising easily from the ground, and flying to the river—sometimes half a mile distant.

The specimen was in fine plumage and excellent condition, and made a very clean, perfect specimen when prepared. It measured as follows:—Length, 27 inches; extent, 57; wing, 17; culmen, 2·25; tarsus, 2; middle toe, 1·75. Its weight was 5¼ lbs. Bill deep flesh-color, the upper mandible with a salmon-colored tinge, and the lower with a rosy pink flush; the terminal ungui nearly white; the commissures enclose an elongate oval space of deep black; iris very dark brown; eyelids greenish-white; tarsi and toes purple-lake, the soles of the feet dingy Naples-yellow.

A remarkable feature of this specimen is that one or two of the primaries are entirely pure white, while most of the remaining ones have longitudinal spaces, of greater or less extent, on the inner webs. The question arises, whether this is merely a case of partial albinism, or a change produced by the modified condition of its food and mode of life.—ROBERT RIDGWAY.

GEOLOGY.

DEEP SEA TEMPERATURE IN THE ANTARCTIC SEA.—In the Report to the Admiralty of Capt. G. S. Nares, of H. M. S. Challenger, dated Melbourne, March 25, 1874, Capt. Nares, speaking of the temperature of the ocean, especially near the pack edge of the ice, says:—"At a short distance from the pack, the surface water rose to 32°, but at a depth of 40 fathoms we always found the temperature to be 29°; this continued to 300 fathoms, the depth in which most of the icebergs float, after which there is a stratum of slightly warmer water of 33° or 34°. As the thermometers had to pass through these two belts of water before reaching the bottom, the indices registered those temperatures, and it was impossible to obtain the exact temperature of the bottom whilst near the ice, but the observations made in lower latitudes show that it is about 31°. More exact results could not have been obtained even had Mr. Siemens' apparatus been on board."

ORIGIN OF THE VALLEY OF THE RHINE.—Geologists intending to travel up the Rhine should by all means read an interesting paper by Prof. A. C. Ramsay on the origin of the Valley of the Rhine, contained in the Quarterly Journal of the London Geological Society (May 1, 1874). He states that the valley during portions of the miocene tertiary period was drained by a river flowing from north southwards, and after the upheaval of the Alps the present river originated and flowed through an elevated plain formed of miocene rocks, leaving the existing plain, "which to the uninstructed eye presents the deceptive appearance of once having been occupied by a great lake."

ANTHROPOLOGY.

EXTENT OF THE ANCIENT CIVILIZATION OF PERU.—Prof. C. F. Hart writes to the president of the Anthropological Society of Berlin, that in a journey to the river Amazon he found some pieces of pottery of which some recall curious forms discovered in Peru, and which prove that the ancient Peruvian civilization extended to the eastern side of the Andes.

MICROSCOPY.

SPHÆRAPHIDES IN TEA LEAVES. — The present interest in the question of adulteration of tea leaves gives special importance to Mr. George Gulliver's discovery that the parenchyma of these leaves is thickly studded with sphæraphides, apparently of oxalate of lime, having a mean diameter of about $\frac{1}{1000}$ inch. They have hitherto escaped notice, being not easy to find on account of the opacity and density of the parts. Soaking, or boiling the leaves in a potash solution, separates the epidermis (which is composed of cells with sinuous margins, and smooth, taper, slightly curved hairs, with the addition of oval stomata on the under side) and exposes distinctly the parenchyma, nerves, and sphæraphides. He has found potash equally useful in exposing the crystals in other plants.

NEW MICROSCOPICAL SOCIETIES.—A new society has been organized in Australia, known as the "Microscopical Society of Victoria." Mr. W. H. Archer is the first President.

A Microscopical Department of the Providence Franklin Society has been established, with the following officers for the present year:—*Chairman*, Professor Eli W. Blake, Jr.; *Vice-Chairman*, A. O. Tilden; *Secretary*, Professor John Peirce; *Cabinet Keeper*, N. N. Mason; *Treasurer*, Dr. C. B. Johnson.

The "Indiana Microscopical Society" was incorporated February 16, 1874. It is located at Indianapolis, and holds monthly meetings.

APPEARANCES OF THE BLOOD IN MELANOSIS.— M. Nepveau represents that the blood of persons affected with melanotic tumors becomes marked by the presence of an excessive proportion of leucocytes which are also filled with dark granules; the red corpuscles when seen in masses have more or less of a sepia tint; and the serum contains reddish-brown granules, and flexible casts resembling hyaline casts which seem to be derived from the capillaries.

ACHROMATIC BULL'S EYE CONDENSER.—This unusual accessory was exhibited by Mr. Ingpen at a late meeting of the Queckett Club.

Embedding Tissues.—At the Queckett Club wax was spoken of as the chosen material for embedding tissues preparatory to cutting thin sections. Dr. Matthews preferred paraffine to beeswax. Dr. George Hoggan, however, considered carrot preferable to wax, and elder pith better than either.

Glycerine Mounting. — According to Dr. George Hoggan, glycerine is used almost universally for mounting in France. A little paraffine is run around the edge of the cover-glass, and a solution of sealing wax painted over it.

NOTES.

Professor Jeffries Wyman, of Cambridge, died suddenly at Bethlehem, N. H., on September 4th. For many years Professor Wyman had been in delicate health and obliged to spend the winter months in Florida, while the heat of summer was avoided by excursions to the mountains, and it was hoped that with the great care he was taking he would be spared for many years to come; especially did this seem probable from his apparently restored condition on his return from Florida last spring, when he seemed to have renewed vigor for the labors before him, and commenced to put the material he had collected during his Florida trips in order for publication. This was so far advanced that at the time of his decease he was engaged in printing his memoir upon the Shell-mounds of Florida, a work that it is greatly to be hoped was so far completed in manuscript as to ensure its publication, as it will undoubtedly exhibit the thoroughness and cautiousness with which his investigations were made.

Professor Wyman was born in Chelmsford, Mass., August 11, 1814. He graduated at Harvard in the class of 1833, and four years after received his degree of M. D. He then passed two years of study in Europe, and soon after returning to this country accepted the position of Professor of Anatomy at the Hampden Sidney College of Virginia, which place he held until 1847, when he accepted the Hersey Professorship of Anatomy and Physiology at Harvard, which position he held at the time of his decease. He was one of the original Trustees, appointed by Mr. Peabody, of the Peabody Museum of American Ethnology and Archæology, and had from the first held the position of Curator of that Museum which owes so much to his care and labors. He always took an active part in the Boston Society of Natural History, and succeeded Dr. Warren in the office of president, which office he held until 1870 when the state of his health compelled him to resign the chair. He was one of the original members and first officers of the American Association for the Advancement of Science, and was also an original member of the National Academy. For many years he acted on the council of the American Academy of Arts and Sciences, and was an honored member of many other societies. Professor Wyman was of a singularly modest and retiring disposition, and though a constant and most laborious worker, his reluctance to appear in public, and his extreme modesty regarding the results he attained, has prevented the world from sharing in but a very small part of his great knowledge, as his publications have been comparatively few in number. Ever ready to assist and guide those who sought his council he was, while scientifically severe, a most genial and thorough friend, and was greatly honored and respected by his pupils and friends.

In his death humanity loses an upright, reliable and strictly honest man, and science one of the most thorough and cautious of investigators.

The French Association for the Advancement of Science held its third meeting at Lille, Aug. 20th, with a large number of foreign scientists in attendance. Over one hundred and fifty persons read papers during the meeting. One of the attractions was a visit to the new laboratory of experimental zoology at Vimereux, near Boulogne. There was also an excursion to Bruges and Antwerp. The session lasted for eight days.

The International Congress of Anthropology and prehistoric Archæology opened Aug. 7, at Stockholm, with an attendance of 800 members, of which more than 300 were foreigners. Everything betokened a brilliant meeting.

The new geological survey of Pennsylvania is being pushed with much vigor under the direction of Prof. J. P. Lesley. $30,000 annually for three years have been voted by the legislature.

Professor Carl Moebius left Kiel on the 25th of July for Mauritius. He will remain there five or six months to study the marine fauna of the island and make collections for the Prussian Universities.

THE

AMERICAN NATURALIST.

Vol. VIII. – NOVEMBER, 1874. – No. 11.

ADDRESS OF PROFESSOR JOSEPH LOVERING.*

[*Concluded from October Number.*]

An interesting question, which has waited thousands of years even to be asked, and may wait still longer for an all-sufficient answer, relates to the motion of what were once called the fixed stars. If numbers count for anything, this is the grandest problem which can be presented to the mind of the astronomer. The argument from probabilities, which reposes on a substantial mathematical foundation, is loud in affirming some kind of motion, and repudiates the notion of absolute rest. We must place the stars outside the pale of science, and where no process of reasoning can reach them, or we must suppose that they subscribe to the universal law of all matter which we know, and exert attractive or repulsive forces upon each other. There may be one solitary body, or more probably an ideal point of space, the centre of gravity of the material universe, around which there is equilibrium: but everywhere else there must be motion. Though distance may reduce the effect of each one of the forces to a minimum, in the aggregate their influence will not be insignificant. The sun must share the common lot of the stars unless we repeat the folly of ancestral science, at which we now smile, and transfer

---

*The retiring President of the American Association for the Advancement of Science, delivered at the Hartford meeting.

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

the throne of the heaven of matter from the earth to the centre of our own little system. If the sun move, a new order of parallactic motion springs up in sidereal astronomy. The process of elimination requires the mathematician to calculate the direction and velocity of the motion of the sun which will leave behind it the smallest unexplained residuum: and this remainder is the motion of the stars themselves. The delicacy of the problem lies in the minuteness of the quantities to be observed and in the assumptions which must be made in regard to the distances of the stars; only a few of which have been positively computed from parallax. However, a result has been reached, highly probable in the sun's case, but which can be converted into absolute values for other stars only so fast as their individual distances are discovered. Here again physics and chemistry, with the spectroscope in hand, have come to the aid of astronomy and geometry. Should it appear that the conclusions from spectrum analysis must be questioned, the attempt was brave, and even a defeat would be honorable.

In 1675, a Danish astronomer observed the novel fact that the frequency in the eclipses of Jupiter's satellites fluctuated with the motion of the planet to or from the earth. He hit upon a happy explanation, viz: that the swift light takes more or less time to telegraph the astronomical news across the omnipresent lines of force. This early observation is the avant-courier of a host of others which have slowly followed in close array. That of a blind musician comes next. He noticed, in 1835, that the pitch of a steam-whistle, on the Lowell Railroad, fell suddenly as the locomotive passed him. Unfortunately, Munroe's observation was never published, although he sought and found an explanation of what was then a strange fact. In this case, the whistle sends the message, the waves of sound transmit it, and the ear is the register: but the changing distance modifies the time. In 1842, Doppler of Prague was led, by theoretical considerations, to formulate the proposition, now known in science as Doppler's principle: that the color of light and the pitch of sound, as they tell upon the senses, are changed by the relative velocity of the observer and the origin of the disturbance. In 1845, Buy Ballot made experiments upon the railroads in the Netherlands, and Scott Russell repeated them on English railroads, which confirmed the theory in the case of sound. In the application of the theory to color, few astronomers will be willing to follow Doppler in all his extravagancies.

If it be true, theoretically, that the relative velocity of light, the wave-length of transmission, and the period of oscillation in the ether, are altered by the relative motion of the observer and the place from which the undulation starts, it is obvious that all other velocities have but a small chance in competition with the velocity of light, and that slight changes of color, if physically real as Doppler supposed, would fail of being recognized even by the eye of a painter. To interpose the spectroscope, and observe the change of refrangibility by the displacement of the sharp lines of the spectrum, was a lucky escape from this embarrassment. After Huggins had tried his hand at this new method, with a small telescope, upon the brightest of all the stars, he was supplied by the Royal Society of London with a larger instrument to pursue the investigation. The results of his spectroscopic inquiry into the motions of many stars have been published. Where these results have conflicted with the foregone conclusions of astronomy, Huggins has not hesitated to arraign the accuracy of astronomical data and methods. I have freely admitted the delicacy and difficulty of the geometrical process. The spectroscopic analysis, when applied to the same problem, walks upon slippery ground and must take heed lest it also fall. The alleged displacement is a nice quantity, and instrumental sources of error have been pointed out which may explain away the whole of it. I lay no stress upon the large difference between Vogel and Huggins in the *quantity* of motion which spectrum analysis ascribes to Sirius, inasmuch as the direction of the motion is the same. We do not yet know all the elements which the earth contains. The spectroscope has already added four to the number. There is reason to think that the stars, though having some substances in common with the earth and sun, are not without their peculiarities. The lines in the stellar spectra may be out of position, not because they are the displaced lines of sodium, magnesium, and hydrogen, but in consequence of novelties in the gaseous atmospheres of the stars. Still, there will be a presumption, perhaps a probability, in favor of Huggins' deduction, if it rest on a sound basis of theory. If there is any weakness in the physical and mathematical foundation of his argument, gratifying as it is to the imagination and the aspirations of science, the whole superstructure must fall.

I am thus suddenly brought face to face, with the second head of my subject: the mathematical and philosophical state of the physical sciences.

The luminiferous ether and the undulatory theory of light have always troubled what is supposed to be the imperturbable character of the mathematics. The proof of a theory is indisputable when it can predict consequences, and call successfully upon the observer to fulfil its prophecies. It is the boast of astronomers that the law of gravitation thus vindicates itself. The undulatory theory of light has shown a wonderful facility of adaptation to each new exigency in optics, and has opened the eye of observation to see what might never have been discovered without the promptings of theory. But this doctrine, and that of gravitation also, have more than once been arrested in their swift march and obliged to show their credentials. After Fresnel and Young had secured a firm foothold for Huyghens' theory of light in mechanics and experiment, questions arose which have perplexed, if not baffled, the best mathematical skill. How is the ether affected by the gross matter which it invests and permeates? Does it move when they move? If not, does the relative motion between the ether and other matter change the length of the undulation or the time of oscillation? These queries cannot be satisfactorily answered by analogy, for analogy is in some respects wanting between the ether and any other substance. Astronomy says that aberration cannot be explained unless the ether is at rest. Optics replies that refraction cannot be explained unless the ether moves. Fresnel produced a reconciliation by a compromise. The ether moves with a *fractional* velocity large enough to satisfy refraction, but too small to disturb sensibly the astronomer's aberration. In 1814, Arago reported to Fresnel that he found no sensible difference in the prismatic refraction of light, whether the earth was moving with full speed towards a star or in the opposite direction, and asked for an explanation. Fresnel submitted the question to mathematical analysis, and demonstrated, that whatever change was produced by the motion of the prism in the relative velocity of light, the wave-length in the prism, and the refraction, was compensated by the physiological aberration when the rays emerged. Very recently, Ketteler of Bonn has gone over the whole ground again with great care, studying not only Arago's case but the general one, in which the direction of the light made any angle with the motion of the earth: and he proves that the light will always enter the eye in the same apparent direction as it would have done if the earth were at rest. The mathematical and physical view taken of this subject by Fresnel, has been under discussion for sixty years, and forty eminent physicists and mathematicians might be enumerated who have taken part in it. Fresnel's explanation has encountered difficulties and objections. Still, it is consistent not only with Arago's negative result but with the experiments on diffraction by Fizeau and Babinet, and the preponderance of mathematical evidence is on that side. Mr. Huggins runs counter to the general drift of physical and algebraical testimony (although he appears to be sustained by the high authority of Maxwell), when he attributes some displacement of the spectrum lines to the motion of the earth, and qualifies the observed displacement on that account. The number of stars which Huggins has observed is insufficient for any sweeping generalization. And yet he seems inclined to explain the revelations of his spectroscope, not by the motion of the stars, but by that of the solar system: because those stars which are in the neighborhood of the place in which astronomers have put the solar apex are moving, apparently, towards the earth, while those in the opposite part of the sky recede. If it be true that the earth's annual motion produces no displacement in the spectrum, then the motion of the solar system produces none. Or, waiving this objection, if the correct explanation has been given by Huggins, astronomers have failed, by their geometrical method, of rising to the full magnitude of the sun's motion. The discrepancy appears to awaken no distrust in Mr. Huggins' mind as to the delicacy of the spectrum analysis or the mathematical basis of his reasoning. On the contrary, he would remove the discrepancy by throwing discredit on the estimate of star-distances made independently by Struve and Argelander from different lines of thought.

Next we ask, if it is certain that even the motion of the luminary will change the true wave-length, the period of oscillation, and the refrangibility, of the light which issues from it. The commonly received opinion on this subject has not been allowed to pass unchallenged. It is fortified by more than one analogy:

but it is said that comparison is not always a reason. It is not denied that, when the sonorous body is approaching, the sound waves are shortened, the number of impulses on the ear by the condensed air is increased, and the pitch of the sound is raised. Possibly, the color of light would follow the same law; but there is no experiment to prove it, and very little analogy exists between the eye and the ear. There is no analogy, whatever, between the subjective sensation by either organ and the physical action of the prism. The questions at issue are these:—Does refraction depend upon the absolute or the relative velocity of light; are the time of oscillation of the particles of ether and the normal wave-length, corresponding to it, changed by any motion of translation in the origin; or is the conservation of these elements an essential attribute of the luminiferous medium. It has been said that Doppler reasoned as if the corpuscular theory of light were true, and then expressed himself in the language of undulations. Evidently, there is an obscurity in the minds of many physicists, and an uncertainty in all, when they reason upon the mechanical constitution of the ether, and the fundamental laws of light. The mathematical theory is not so clear as to be able to dispense with the illumination of experiment. Within the present year, Van der Willigen has published a long and well considered memoir on the theoretical fallacies which vitiate the whole of Huggins' argument for the motion of the stars and nebulæ. His analysis proves that the motion of the luminary will not interfere with the time of oscillation and the wave-length, provided that the origin of the disturbance is not a mathematical point but a vibrating molecule, and that the sphere of action of this molecule upon surrounding molecules is large enough to keep them under its influence during ten or a hundred vibrations, before it is withdrawn by the motion of translation. If this theoretical exposition of the subject should be generally adopted by mathematicians, the spectroscopic observations on the supposed motion of the stars must receive another interpretation. On the other hand, if a luminary is selected which is known to move, independently of spectroscopic observations, and the displacement of the spectrum lines accords with this motion, it will be time to reconsider the mathematical theory, and make our conceptions of the ether conform to the experiment. The spectroscopic observation of Angström on an oblique electric spark does not favor Huggins' views. Secchi testifies to opposite displacements when he examined, with a direct vision spectroscope, the two edges of the sun's equator, one of which was rotating towards him and the other from him, and Vogel has repeated the observation with a reversion-spectroscope. This would have the force of a crucial experiment were it not that an equal displacement was seen on other parallels of latitude, and that the bright bands of the chromosphere were moved but not the dark lines of the solar atmosphere.

When Voltaire visited England in 1727 he saw at the universities the effect of Newton's revolutionary ideas in astronomy. The mechanism of gravitation had exiled the fanciful vortices of Descartes, which were still circulating on the continent. So he wrote: "A Frenchman who comes to London finds many changes in philosophy as in other things: he left the world full, he finds it empty." The same comparison might be made now, not so much between nationalities as between successive stages of scientific development. At the beginning of this century the universe was as empty as an exhausted receiver: now it has filled up again. Nature's abhorrence of a vacuum has been resuscitated, though for other reasons than those which satisfied the Aristotelians. It is the mathematicians and not the metaphysicians who are now discussing the relative merits of the *plenum* and the *vacuum*. Newton in his third letter to Bentley wrote in this wise:—"That gravity should be innate, inherent and essential to matter, so that one body may act upon another at a distance, through a *vacuum*, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man, who has in philosophical matters a competent faculty of thinking, can ever fall into it." Roger Cotes, who was Newton's successor in the chair of mathematics and natural philosophy at Cambridge, was only four years old when the first edition of the *Principia* was issued, and Newton outlived him by ten years. The venerable teacher pronounced upon the young mathematician, his pupil, these few but comprehensive words of eulogy: "If Cotes had lived, we should have known something." The view taken of gravitation by Cotes was not the same as that held by his master. He advocated the proposition that action at a distance must be accepted as one of the primary qualities of matter, admitting of no farther analysis. It was objected by Hobbes and other metaphysicians, that it was inconceivable that a body should act where it was not. All our knowledge of mechanical forces is derived from the conscious effort we ourselves make in producing motion. As this motion employs the machinery of contact, the force of gravitation is wholly outside of all our experience. The advocates of action at a distance reply, that there is no real contact in any case, that the difficulty is the same with the distance of molecules as that of planets, that the mathematics are neither long-sighted nor short-sighted, and that an explanation which suits other forces is good enough for gravitation.

Comte extricated himself from this embarrassment by excluding causes altogether from his positive philosophy. He rejects the word attraction as implying a false analogy, inconsistent with Newton's law of distance. He substitutes the word gravitation, but only as a blind expression by which the facts are generalized. According to Comte's philosophy, the laws of Newton are on an equality with the laws of Kepler, only they are more comprehensive, and the glory of Kepler has the same stamp as that of Newton. Hegel, the eminent German metaphysician, must have looked at the subject in the same light when he wrote these words: — "Kepler discovered the laws of free motion; a discovery of immortal glory. It has since been the fashion to say that Newton first found out the truth of these rules. It has seldom happened that the honor of the first discoverer has been more unjustly transferred to another." Schelling goes farther in the same direction: he degrades the Newtonian law of attraction into an empirical fact, and exalts the laws of Kepler into necessary results of our ideas.

Meanwhile, the Newtonian theory of attraction, under the skilful generalship of the geometers, went forth on its triumphal march through space, conquering great and small, far and near, until its empire became as universal as its name. The whirlpools of Descartes offered but a feeble resistance, and were finally dashed to pieces by the artillery of the parabolic comets; and the rubbish of this fanciful mechanism was cleaned out as completely as the cumbrous epicycles of Ptolemy had been dismantled by Copernicus and Kepler. The mathematicians certified that the solar system was protected against the inroads of comets, and the border warfare of one planet upon another, and that its stability was secure in the hands of gravitation, if only space should be kept open, and the dust and cobwebs which Newton had swept from the skies should not reappear. Prophetic eyes contemplated the possibility of an untimely end to the revolution of planets, if their ever expanding atmospheres should rush in to fill the room vacated by the maelstroms of Descartes. When it was stated that the absence of infinite divisibility in matter, or the coldness of space, would place a limit upon expansion, and, at the worst, that the medium would be too attenuated to produce a sensible check in the headway of planets, and when, in more recent times, even Encke's comet showed but the slightest symptoms of mechanical decay, it was believed that the motion was, in a practical, if not in a mathematical sense, perpetual. Thus it was that the splendors of analysis dimmed the eyes of science to the intrinsic difficulties of Newton's theory, and familiarity with the language of attraction concealed the mystery that was lurking beneath it. A long experience in the treatment of gravitation had supplied mathematicians with a fund of methods and formulas suited to similar cases. As soon as electricity, magnetism and electro-magnetism took form, they also were fitted out with a garment of attractive and repulsive forces acting at a distance: and the theories of Cavendish, Poisson, Aepinus and Ampere, endorsed as they were by such names as Laplace, Plana, Liouville and Green, met with general acceptance.

The seeds, which were destined to take root in a later generation, and disturb if not dislodge the prevalent interpretation of the force of gravitation, were sown by a contemporary of Newton. They found no congenial soil in which they could germinate and fructify until the early part of the present century. At the present moment, we find the luminiferous ether in quiet and undivided possession of the field from which the grosser material of ancient systems had been banished. The *plenum* reigns everywhere; the vacuum is nowhere. Even the corpuscular theory of light, as it came from the hands of its founder, required the reinforcement of an ether. Electricity and magnetism, on a smaller scale, applied similar machinery. If there was a fundamental objection to the conception of forces acting at a distance, certainly the bridge was already built by which the difficulty could be surmounted. The turning-point between the old physics and the new physics was reached in 1837, when Faraday published his experiments on the specific inductive capacity of substances.

This discovery was revolutionary in its character, but it made no great stir in science at the time. The world did not awake to its full significance until the perplexing problem of ocean telegraphs converted it from a theoretical proposition into a practical reality, and forced it on the attention of electricians. The eminent scientific advisers of the cable companies were the first to do justice to Faraday. This is one of the many returns made to theoretical electricity for the support it gave to the most magnificent commercial enterprise.

The discovery of diamagnetism furnished another argument in favor of the new interpretation of physical action. What that new interpretation was is well described by Maxwell. "Faraday, in his mind's eye, saw lines of force traversing all space, where the mathematicians saw centres of force attracting at a distance; Faraday saw a medium where they saw nothing but distance; Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they had found it in a *power* of action at a distance impressed on the electric fluids." The physical statement waited only for the coming of the mathematicians who could translate it into the language of analysis, and prove that it had as precise a numerical consistency as the old view with all the facts of observation. A paper published by Sir William Thomson, when he was an undergraduate at the university of Cambridge, pointed the way. Prof. Maxwell, in his masterly work on electricity and magnetism, which appeared in 1873, has built a monument to Faraday, and unconsciously to himself also, out of the strongest mathematics. For forty years mathematicians and physicists had labored to associate the laws of electrostatics and electrodynamics under some more general expression. An early attempt was made by Gauss in 1835, but his process was published, for the first time, in the recent complete edition of his works. Maxwell objects to the formula of Gauss because it violates the law of the conservation of energy. Weber's method was made known in 1846; but it has not escaped the criticism of Helmholtz. It represents faithfully the laws of Ampere and the facts of induction, and led Weber to an absolute measurement of the electrostatic and electromagnetic units. The ratio of these units, according to the formulas, is a velocity; and experiment shows that this velocity is equal to the velocity of light. As Weber's theory starts with the conception of action at a distance, without any mediation, the effect would be instantaneous, and we are at a loss to discover the physical meaning which he attaches to his velocity. Gauss abandoned his researches in electromagnetism because he could not satisfy his mind in regard to the propagation of its influence in time. Other mathematicians have worked for a solution, but have lost themselves in a cloud of mathematical abstraction. The two theories of light have exhausted all imaginable ways in which force can be gradually transmitted without increase or loss of energy. Maxwell cut the Gordian knot when he selected the luminiferous ether itself as the arena on which to marshal the electromagnetic forces under the symbols of his mathematics, and made light a variety of electromagnetic action. His analysis gave a velocity essentially the same as that of Weber, with the advantage of being a physical reality and not a mere ratio. Of the two volumes of Mr. Maxwell, freighted with the richest and heaviest cargo, the reviewer says: "Their author has, as it were, flown at everything: and, with immense spread of wing and power of beak, he has hunted down his victims in all quarters, and from each has extracted something new and interesting for the intellectual nourishment of his readers." Clear physical views must precede the application of mathematics to any subject. Maxwell and Thomson are liberal in their acknowledgments to Faraday. Mr. Thomson says: "Faraday, without mathematics, divined the result of the mathematical investigation; and, what has proved of infinite value to the mathematicians themselves, he has given them an articulate language in which to express their results. Indeed, the whole language of the *magnetic field* and *lines of force* is Faraday's. It must be said for the mathematicians that they greedily accepted it, and have ever since been most zealous in using it to the best advantage."

It is not expected that the new views of physics will be generally accepted without vigorous opposition. A large amount of intellectual capital has been honestly invested in the fortunes of the other side. The change is recommended by powerful physical arguments, and it disenthralls the theories of science from many metaphysical difficulties which weigh heavily on some minds. On the other hand, the style of mathematics which the innovation introduces is novel and complex; and good mathematicians may find it necessary to go to school again before they can read and understand the strange analysis. It is feared that with many who are not easily deflected from the old ruts, the intricacies of the new mathematics will outweigh the superiority of the new physics.

The old question, in regard to the nature of gravitation, was never settled: it was simply dropped. Now it is revived with as much earnestness as ever, and with more intelligence. Astronomy cast in its own mould the original theories of electrical and magnetic action. The revolution in electricity and magnetism must necessarily react upon astronomy. It was proved by Laplace, from data which would now, probably, require a numerical correction, that the velocity of the force of gravitation could not be less than eight million times the velocity of light; in fact, that it was infinite. Those who believe in action at a distance cannot properly speak of the transmission of gravitation. Force can be transmitted only by matter: either with it or through it. According to their view, action at a distance *is* the force, and it admits of no other illustration, explanation, or analysis. It is not surprising that Faraday and others, who had lost their faith in action at short distances, should have been completely staggered by the ordinary interpretation of the law of gravitation, and that they declared the clause which asserted that the force diminished with the square of the distance to be a violation of the principle of the conservation of force.

Must we then content ourselves with the naked facts of gravitation, as Comte did, or is it possible to resolve them into a mode of action in harmony with our general experience, and which does not shock our conceptions of matter and force? In 1798, Count Rumford wrote thus: "Nobody surely, in his sober senses, has ever pretended to understand the mechanism of gravitation." Probably Rumford had never seen the paper of Le Sage, published by the Berlin Academy in 1782, in which he expounded his mechanical theory of gravitation, to which he had devoted sixty-three years of his life. In a posthumous work, printed in 1818, Le Sage has developed his views more fully. He supposed that bodies were pressed towards one another by the everlasting pelting of ultramundane atoms, inward bound from the immensity of space beyond, the faces of the bodies which looked towards each other being mutually screened from this bombardment. It was objected to this hypothesis, which introduced Lucretius into the society of Newton and his followers, that the collision of atoms with atoms, and with planets, would cause a secular diminution in the force of gravity. Le Sage admitted the fact. But as no one knew that the solar system was eternal, the objection was not fatal. As the necessity for giving a mechanical account of gravitation was not generally felt at the time, the theory of Le Sage fell into oblivion. In 1873, Sir William Thomson resuscitated and republished it. He has fitted it out in a fashionable dress, made out of elastic molecules instead of hard atoms, and has satisfied himself that it is consistent with modern thermo-dynamics and a perennial gravitation.

Let us now look in a wholly different quarter for the mechanical origin of gravitation. In 1870, Prof. Guthrie gave an account of a novel experiment, viz:—the attraction of a light body by a tuning-fork when it was set in vibration. Thomson repeated the experiment upon a suspended eggshell and attracted it by a simple wave of the hand. Thomson remarks "that what gave the great charm to these investigations, for Mr. Guthrie himself, and no doubt also for many of those who heard his expositions and saw his experiments, was, that the results belong to a class of phenomena to which we may hopefully look for discovering the mechanism of magnetic force, and possibly also the mechanism by which the forces of electricity and gravity are transmitted." By a delicate mathematical analysis, Thomson arrives at the theorem that the "average pressure at any point of an incompressible, frictionless fluid, originally at rest, but set in motion and kept in motion by solids, moving to and fro, or whirling round in any manner, through a finite space of it," would explain the attractions just described. Moreover, he is persuaded by other effects besides those of light, that, in the interplanetary spaces and in the best artificial vacuum, the medium which remains has "perfectly decided mechanical qualities, and, among others, that of being able to transmit mechanical energy, in enormous quantities:" and he cherishes the hope that his mathematical theorems on abstract hydrokinetics are of some interest in physics as illustrating the great question of the eighteenth and nineteenth centuries:—Is action at a distance a reality, or is gravitation to be explained, as we now believe magnetic and electric forces must be, by action of intervening matter?

In 1869 and 1873, Prof. Challis of Cambridge, England, published two works on the Principles of Mathematical Physics. They embody the mature reflexions of a mathematical physicist at the advanced age of threescore years and ten. Challis believes that there is sufficient evidence for the existence of ether and atoms as physical realities. He then proceeds to say:—"The fundamental and only admissible idea of *force* is that of *pressure*, exerted either actively by the ether against the surface of the atoms, or as reaction of the atoms on the ether by resistance to that pressure. The principle of deriving fundamental physical conceptions from the indications of the senses does not admit of regarding *gravity*, or any other force varying with distance, as an essential quality of matter, because, according to that principle, we must, in seeking for the simplest idea of physical force, have regard to the sense of *touch*. Now, by this sense, we obtain a perception of force as pressure, distinct and unique, and not involving the variable element of distance, which enters into the perception of force as derived from the sense of sight alone. Thus, on the ground of simplicity as well as of distinct perceptibility, the fundamental idea of force is pressure." As all other matter is passive except when acted upon by the ether, the ether itself, in its quiescent state, must have uniform density. It must be coextensive with the vast regions in which material force is displayed. Challis had prepared himself for the elucidation and defence of his dynamical theory by a profound study of the laws of motion in elastic fluids. From the mathematical forms in which he has expressed these laws he has attempted to derive the principal experimental results in light, heat, gravitation, electricity, and magnetism. Some may think that Mr. Challis has done nothing but clothe his theory in the cast off garments of an obsolete philosophy. If its dress is old, it walks upon new legs. The interplay between ether and atoms is now brought on to the stage, not as a speculation supported by metaphysical and theological arguments, but as a physical reality with mathematical supports. I should do great injustice to this author if I left the impression that he himself claimed to have covered the whole ground of his system by proof. Mathematical difficulties prevented him from reaching a numerical value for the resultant action of a wave of ether upon the atom. What he has written is the guidepost, pointing the direction in which science is next to travel: but the end of the journey is yet a great way off. The repeated protests of Mr. Challis against the popular physics of the day, and his bold proclamation of the native, independent motion of the ether, have aroused criticism. What prevents the free ether, asks the late Sir John Herschel, from expanding into infinite space? Mr. Challis replies that we know nothing about infinite space or what happens there, but the existence of the ether, where our experience can follow it, is a physical reality. The source of the motion which the ether acquires is not the sun: for the most efficient cause of solar radiation is gravitation and condensation. Our author avoids the vicious circle of making gravitation, first the reason and afterwards the consequence of the motion of the ether. He says: "It follows that the sun's heat, and the heat of masses in general, are stable quantities, oscillating, it may be, like the planetary motions, about *mean* values, but never permanently changing, so long as the Upholder of the universe conserves the force of the ether and the qualities of the atoms. There is no law of destructibility: but the same Will that conserves can in a moment destroy." The following remarks upon this theory deserve our attention. "The explanation of any action between distant bodies by means of a clearly conceivable process, going on in the intervening medium, is an achievement of the highest scientific value. Of all such actions that of gravitation is the most universal and the most mysterious. Whatever theory of the constitution of bodies holds out a prospect of the ultimate explanation of the process by which gravitation is effected, men of science will be found ready to devote the whole remainder of their lives to the development of that theory."

The hypotheses of Challis and Le Sage have one thing in common; the motion of the ether and the driving storm of atoms must come from outside the world of stars. "On either theory, the universe is not even temporarily automatic, but must be fed from moment to moment by an agency external to itself." Our science is not a finality. The material order which we are said to know makes heavy drafts upon an older or remoter one, and that again upon a third. The world, as science looks at it, is not self-sustaining. We may abandon the hope of explaining gravitation, and make attraction itself the primordial cause. Our refuge then is in the sun. When we qualify the conservation of energy by the dissipation of energy, the last of which is as much an induction of science as the first, the material fabric which we have constructed still demands outward support. Thomson calculates that, within the historical period, the sun has emitted hundreds of times as much mechanical energy as is contained in the united motions of all the planets. This energy, he says, is dissipated more and more widely through endless space, and never has been, probably never can be, restored to the sun, without acts as much beyond the scope of human intelligence as a creation or annihilation of energy, or of matter itself, would be.

From the earliest dawn of intellectual life, a general theory of the constitution of matter has been a fruitful subject of debate, and human science and philosophy have ever been dashing their heads against the intractable atoms. The eagerness of the discussion was the greater, the more hopeless the solution. For every man who set up an hypothesis upon the subject there were half a dozen others to knock it down; until at last speculation, which bore no fruit, was suspended. A lingering interest still hung around the question, whether matter was not infinitely divisible, and the atomic philosophers were not chasing a chimera. From every new decision on this single point there was an appeal, and the foothold which the atoms had secured in chemistry was gradually subsiding. Of a sudden, the atomic theory has gained a new lease of life. But the hero of the new drama is not the atom but the molecule. In all the physical sciences, including astronomy, the war has been carried home to the molecules: and the intellectual victories of this and the next generation will be on this narrow field. From the outlying provinces of physics; from the sun, the stars and the nebulæ; from the comets and meteors; from the zodiacal light and the aurora; from the exquisitely tempered and mysterious ether; the forces of nature have been moving in converging lines to this common battle ground, and some shouts of victory have already been heard. In the long and memorable controversy between Newton and Leibnitz, and their adherents, as to the true measure of force, it was charged against the Newtonian rule that force was irrecoverably lost whenever a collision occurred between hard, inelastic bodies. The answer was, that nature had anticipated the objection and had avoided this kind of matter. Inelastic bodies were yielding bodies, and the force which had disappeared from the motion had done its work in changing the shape. But unless the body could recover its original figure by elasticity, there was no potential energy and force was annihilated. It is now believed, and to a large extent demonstrated, that the force, apparently lost, has been transformed into heat, electricity or some other kind of molecular motion, of which the change of shape is only the outward sign. The establishment on a firm foundation of theory and experiment of the so-called conservation of energy, the child of the correlation of physical forces, is one of the first fruits of molecular mechanics.

It is no disparagement of this discovery, on which was concentrated the power of several minds, to call it an extension, though a vast one, of Newton's law of inertia, of Leibnitz's *vis viva*, and of Huyghens' and Bernouilli's conservation of living forces; these older axioms of mechanics having free range only in astronomy, where friction, resistance and collision do not interfere. The conservation of energy, in its extended signification, promises to be, like its forerunners, a valuable guide to discovery, especially in the dark places into which physical science has now penetrated. The caution which Lagrange has given in reference to similar mechanical principles, such as the conservation of the motion of the centre of gravity, the conservation of moments of rotation, the preservation of areas, and the principle of least action, is not without its applicability to the new generalization. Lagrange accepts them all as results of the known laws of mechanics and not as the essence of the laws of nature. The most that physical science can assert is that it possesses no evidence of the destructibility of matter or force.

It is not pretended that the existence of atoms has been or can be proved or disproved. Some chemists think that the atomic theory is the life of chemistry: others have abandoned it. Its importance is lost in that of the molecular theory. And what has this accomplished to justify its existence? If we define the molecule of any substance as the smallest mass of that substance which retains all its chemical properties, we can start with the extensive generalization of Avogadro and Ampere, that an equal volume of every kind of matter in the state of vapor, and under the same pressure and temperature, contains an equal number of such molecules. The conception of matter as consisting of parts, which are perpetually flying over their microscopic orbits and producing by their fortuitous concourse all the observed qualities of bodies, is as old as Lucretius. He saw the magnified symbol of his hypothesis in the motes which chase one another in the sunbeam. One of the Bernouillis thought that the pressure of gases might be caused by the incessant impact of these little masses on the vessel which held them. The discovery that heat was a motion and not a substance, foreshadowed by Bacon, made probable by Rumford and Davy, and rigidly proved by Mayer and Joule when they obtained its exact mechanical equivalent, opened the way to the dynamical theory of gases. Joule calculated the velocity of this promiscuous artillery, rendered harmless by the minuteness of the missiles, and found that the boasted guns of modern warfare could not compete with it. Clausius consummated the kinetic theory of gases by his powerful mathematics, and derived from it the experimental laws of Mariotte, Gay-Lussac and Charles. By the assumption of data, more or less plausible, several mathematicians have succeeded in computing the sizes and the masses of the molecules and some of the elements of their motion. It should not be forgotten that mathematical analysis is only a rigid system of logic by which wrong premises conduct the more surely to an incorrect conclusion. To claim for all the conclusions which have been published in relation to the molecules the certainty which fairly belongs to some of them would prejudice the whole cause.

One of the most interesting investigations in molecular mechanics was published by Helmholtz in 1858. It is a mathematical discussion of what he calls ring-vortices in a perfect, frictionless fluid. Helmholtz has demonstrated that such vortices possess a perpetuity and an inviolability once thought to be realized only by the eternal atoms. The ring-vortices may hustle one another, and pass through endless transformations, but they cannot be broken or stopped. Thomson seized upon them as the impersonation of the indestructible but plastic molecule which he was looking for, to satisfy the present condition of physical science. The element of the new physics is not an atom or a congeries of atoms but a whirling vapor. The molecules of the same substance have one invariable and unchangeable mass: they are all tuned to one standard pitch and, when incandescent, emit the same kind of light. The music of the spheres has left the heavens and condescended to the rhythmic molecules. There is here no birth or death or variation of species. If other masses than the precise ones which represent the elements have been eliminated, where, asks Maxwell, have they gone? The spectroscope does not show them in the stars or nebulæ. The hydrogen and sodium of remotest space are in unison with the hydrogen and sodium of earth.

In the phraseology of our mechanics we define matter and force as if they had an independent existence. But we have no conception of inert matter or of disembodied force. All we know of matter is its pressure and its motion. The old atom had only potential energy; the energy of its substitute, the molecule, is partly potential and partly kinetic. If it could be shown that all the phenomena displayed in the physical world were simply transmutations of the original energy existing in the molecules, physical science would be satisfied. Where physical science ends, natural philosophy, which is not wholly exploded from our vocabulary, begins. Natural philosophy can give no account of energy when disconnected with an ever present Intelligence and Will. In Herschel's beautiful dialogue on atoms, after one of the speakers had explained all the wonderful exhibitions of nature as the work of natural forces, Hermione replies: — "Wonderful, indeed! Anyhow, they must have not only good memories but astonishing presence of mind, to be always ready to act, and always to act, without mistake, according to the primary laws of their being, in every complication that occurs." And elsewhere, "Action, without will or effort, is to us, constituted as we are, unrealizable, unknowable, inconceivable." The monads of Leibnitz and the demons of Maxwell express in words the personality implied in every manifestation of force.

In this imperfect sketch of the increased resources and the present attitude of the physical sciences I have not aimed to speak as an advocate; much less to sit as a judge. The great problem of the day is, how to subject all physical phenomena to dynamical laws. With all the experimental devices, and all the mathematical appliances of this generation, the human mind has been baffled in its attempts to construct a universal science of physics. But nothing will discourage it. When foiled in one direction, it will attack in another. Science is not destructive, but progressive. While its theories change, the facts remain. Its generalizations are widening and deepening from age to age. We may extend to all the theories of physical science the remark of Grote which Challis quotes in favor of his own: — "its fruitfulness is its correctibility." Instead of being disheartened by difficulties, the true man of science will congratulate himself in the words of Vauvenargues, that he lives in a world fertile in obstacles. Immortality would be no boon if there were not something left to discover as well as to love. Fortunate, thought Fontenelle, was

Newton, beyond all other men, in having a whole fresh universe before him, waiting for an explanation. But science wants no Alexanders weeping because there are not other worlds to conquer. For every heroic Columbus, who launches forth, in however frail a bark, upon untried oceans, seeing before him rich continents where others behold only a wilderness of waters, there are precious discoveries in reserve. Surely the time has not yet come when the men in any section in this Association can fold their arms and say: — It is finished. Unless our physicists are contented to lag behind and gather up the crumbs which fall from the rich laboratories and studies of Europe, they must unite to delicate manipulation the power of mathematical analysis. Mathematics wins victories where experiment has been beaten. With good reason we applaud the many brilliant successes of instrumental research. Mathematical analysis, with its multitudinous adaptations, is the only key which will fit the most intricate wards in the treasury of science. With the help of her mathematical physicists, Great Britain has now taken a position in science which she has not held before since the days of Newton. In Germany, the physicists do not hold back from the most difficult problems of the day, because they are led along by experiment on one arm and by mathematics on the other. The zeal of the Italian scientists prevails, over even the terrors of Vesuvius, and makes them ready to become martyrs, like Pliny the elder, to nature and humanity. France, too, out of the very ashes of her humiliation, sends an inspiring word to us. Since her defeat, her scientific spirit has been aroused as it was after the days of the first revolution. Her Association for the Advancement of Science is only a two year old infant; but it has sprung into existence, like Minerva from the head of Jupiter, fullgrown and equipped. Already it has displayed a vitality and a prosperity which this Association, in its opening manhood, has not yet acquired. The words of its first President are as true for the United States as for France: — that the strength and glory of a country are not in its arms but in its science.

THE METAMORPHOSIS OF FLIES.* II.

BY DR. AUGUSTUS WEISSMANN.

WE now attempt to consider morphologically the phenomena of the development of the Muscidæ, as discussed in the foregoing chapters. In the first place, the theories above laid down seem to be thoroughly established, *i. e.* that we have in the metamorphosis of the flies nothing to do with a simple change of skin. Indeed, the additional metamorphosis is accompanied by a casting aside and new formation of the chitinous framework which underlies the body, but this has a very subordinate signification. The systems of organs of the larva disappear simultaneously, it may be completely, it may be only histologically; and out of the fragments the tissues build up a new body. It is a matter of doubt whether to consider the larva and pupa as one and the same individual, or whether we have not in reality an alternation of generations. I think that those who speak of a metagenesis in certain Echinoderms should regard this also as such, if with V. Carus,† we consider metamorphosis as a series of developments in which the animal, during a certain stage in its development, is provided with provisional organs; but metagenesis as that in which this whole developmental stage itself (Amme) must be considered as a provisional one, so that it readily follows that the system of organs of the larva taken collectively is provisional, or in other words, that the larva itself is a provisional stage, while the fly must be considered as a new individual; such process taking rank as an alternation of generations. At all events from the Pluteus-form larva new organs arise in the sea star, as from the larva in the fly. There is the alimentary canal and the water vascular system, which last, though in a plainly undeveloped condition, is already partially developed in the larva. Here we have, except the hypoderm of the abdominal segments of the larva, no parts which pass into the pupa without previously undergoing a total revolution. The alimentary canal and the water-vascular system of the Echinoderm larva at no time perform their function; they continue to develop more perfectly; they grow more complicated in their structure; they throw off their parts singly; they only hold in reserve their histological structure in order to become physiologically capable of performing their functions.

---

* Forming the closing chapter in "Die Entwicklung der Dipteren," 1864.

† System der thierischen Morphologie, Leipzig, 1853, p. 264.

In the Muscidæ, on the contrary, each organ of the larva does not become entirely lost, though bordering upon a histolysis, *i. e.* becoming functionally incapable, their histological elements dissolve themselves into a blastema, from which a new histological element must arise. The only difference from the total destruction, such as befalls the muscles, the fat bodies, etc., is this, that the destruction of tissues here becomes a continuous process, and the new organs are built up out of the same material which composed the old ones. This obtains in the intestine, the nervous system and the dorsal vessel. But a surprising analogy to the development of the Echinoderm occurs in the formation of the imaginal disks. As the body of the Echinoderm selects at several points around the alimentary canal of the larva indifferent cell masses, and then all unite and consolidate into a single mass, so arise at different places within the body of the fly larva—here still in genetic relation with the organs of the larva—masses of indifferent cells, which become differentiated in the course of the development of the different parts of the imago, and become transformed into a common whole. It cannot be considered as an essential deviation, that in the Pluteus larva these cell masses are formed during the life of the larva, while in the muscid larva they are formed before that, in the egg; and this deviation occurs to such a slight extent, as we have seen above, that a pair of the formative disks, those out of which the upper half of the prothorax is formed, here makes an exception, and is only developed shortly before the pupation. Had we considered the formation of the cell masses of the Echinoderm larva as buds, then for a still stronger reason is the formation of the imaginal disks of the Muscidæ a budding process. They are outgrowths of the tegumentary membrane of the nerves and tracheæ of tissues, which, if they are not histologically, are yet physiologically equivalents to the complete fibrous tissues of the vertebrates. Both tissues are essentially derived from an amorphous, fundamental substance, which seems to have the capabilities which the more recent studies in histology ascribe to the peculiar restorative quality of the connective tissue of vertebrates, *i. e.* of building up cells, and of returning to that from which it originated.

I find it generally true that the nuclei lying near a recent disk become metamorphosed into disk-forming cells; that they surround themselves with cells, and multiply like the other disk-cells. Such a process may be seen in the exceptionally late appearance of the upper prothoracic disks. These disks are already formed in the egg out of the embryo cells,—out of the same material as the tegumentary membrane with which they develop. They could only in an ideal sense be regarded as outgrowths of this tegumentary membrane; so the upper prothoracic disks are, in reality, nothing but outgrowths. The nuclei of the peritoneal skin form cells, and increase in number, constituting the disks. We have here a bud which scarcely differs from the buds which are concerned in the formation of new stigmata in the first moulting of the larva, and we should almost err in considering the morphological value of this disk to regard it as a true imaginal disk; it should at least not be compared with those of the free Tipulidæ larvæ, in which they have a by far more complicated structure, while they are considerably larger, and are indicated contemporaneously with the formation of the other disks of the thorax.

As I cannot agree with that opinion which regards the well-known metamorphosis of Echinoderms as a metagenesis, so am I still far from proposing that there is such a metamorphosis in the Muscidæ. We must certainly, with V. Carus and J. Müller, consider it in this respect as irrelevant whether the nurse produces one or more germs (in a monogenous way); whether the animal growing from the egg develops into a sexual form, or whether it, not capable of that, at the end of its development produces germs (buds) which build up a sexual animal; or whether the series of developmental forms from the embryo up to the sexually ripe animal end in one or two individuals. The answer in both cases seems to me not doubtful. In the Echinoderms as in the Muscidæ we have to deal with a metamorphosis, not with an alternation of generations. Larva and sexually mature animal are one and the same individual. In the Echinoderms it seems to me this is evident in that the internal organs (intestine and water canal system) are present, and *without any interruption of their functions* pass over from the larval stage to the adult sea star; so that a single germ will not from the beginning pass by gradual differentiation into the perfected animal, but rather distinct accumulations of cells take place and in the course of development give rise to the new "individual."

But in the flies there is another fact which compels us to look upon the larva and pupa as a single individual, however slight may be the community in organs and external form between the two developmental stages. It is this circumstance that the same mass of organized substance constitutes the body of the growing larva, as of the fly. *During the metamorphosis no growth takes place.* The larval skin is thrown off, the insect forms a case around itself beneath whose shelter it remains and builds up the final form of the perfect insect. It takes in or gives out products of combustion of the still unceasing process of respiration. We have in a manner a second egg-development, and as we consider egg and larva as a single individual, so must the pupa, though not containing the undeveloped larva as a yolk, be considered as one and the same individual. But it does not happen that there is no stage in the development of the pupa in which the larval organs are not present; though the organs of flight are indeed newly formed, the exclusion of the larval body does not take place suddenly, but very gradually it grows parallel with a whole series of formations of new structures. Larva and fly overlap each other. There can be no doubt that they are one and the same individual; that their development also is to be considered as a metamorphosis.

It is still the most complete metamorphosis conceivable which we find in the Muscidæ, far more complete—I do not profess to speak from more recent observations—than, for example, the metamorphosis of the Lepidoptera. The destruction of the larval organs is in the Lepidoptera much less complete, as the lepidopterous pupa has the power of moving its hind-body. The muscles of the larval segments concerned in the movements seem to remain, and the nervous power is not interrupted; there is a communication between the nervous centre and the organism; the consciousness of the animal remains, it reacts on stimulation. According to Herold the pulsation of the dorsal vessel goes on. The pupa in short ceases not for a moment to be a living being, while the life of the Muscid is as latent as that of the fertilized egg.

Through the transfer of many organs of the larva into the pupa there is less need of the rebuilding of parts. I find that even in the Lepidoptera *the origin of the thorax is from the hypodermis of the larva;* that no thoracic disks are developed within the body, but that the appendages of the thoracic segments grow by a direct metamorphosis from the limbs. The wings alone have a special mode of development and in a very peculiar way.

I think that the kind and mode of formation of the thorax in the pupa of insects have the closest connection with, at first sight, a very subordinate circumstance, the presence or absence of true limbs in the larva. *I think, that especially where the three segments of the larva immediately following the head bear appendages, the corresponding appendages—the legs—of the adult insect, are formed by a simple metamorphosis; while on the other hand, when these limbs are wanting in the larva, there are found thoracic scales within the body of the larva; and not only the appendages but also the walls of the body are new structures.*

All my observations, new and old, agree with this view; among others the earlier observations on the larva of the gnat, already spoken of, which have only anal limbs, but no typical segmental appendages, and in which the structure of the thorax is the same as in the Muscidæ.

When it is said that the life of the insect is latent in the pupa, that the usual functions of animal life, such as motion and sensibility are wanting, I might speak of the Muscidæ alone, and say this of all insects with a similar mode of formation of the thorax. There comes into consideration here, not only the greater or less independence of development, the more or less marked absence of the larval organs, but also the period of the formation of the pupa. In the Tipulid larva, noticed above, the larval and pupal states are more intimately blended than in the Muscids. The thorax and head of the pupa are already fully formed, while the larva is actively swimming about. When the larva skin is cast off the muscles of the pupa are already at work; the functions of animal life suffer no interruption.

But in the Muscidæ the loss of the larval parts precedes the formation of the body of the pupa. Hence we perceive no motion, and in fact the animal life is latent. The circulation of the blood ceases, the peripheral nervous system is destroyed, and the central system loses any power of action; at the same time all the inner organs become incapable of farther functional conditions. The development of new systems of organs begins with the rise of indifferent cells in the mass to be sloughed off, much as happens in the formation of the blastoderm in the egg. This renewal of the structure is seen in a measure in the internal organs. We can distinguish four modes of development, according to which the parts of the fly originate. Either certain parts of the larvæ become persistent, under modification, or the larval organs become a foundation for the parts of a fly, but are thrown off, cell by cell, ere they assume a definite character. The third and last kind is when an entirely new development of parts takes place, the beginning of which either dates at the embryonic or larval period or at the close of the pupa state.

Let us consider this single mode of development more closely as regards the direct transfer of the larval parts alone from the hypodermis of the eight hinder larval segments, which are afterwards developed into the abdomen of the fly. The second mode occurs in the alimentary canal, the Malpighian vessels, with the dorsal vessel and the central part of the nervous system. The same process is observed in all these organs, that of their removal, cell by cell, with a succeeding new development. I might term it a *histolysis.* The histological elements of the organ—simple as well as compound—suffer a fatty degeneration; there remains a residuary mass filled mostly with fat molecules. In the nervous centres and Malpighian vessels the nuclei of the cells become persistent, and perhaps give rise to the development of new histological elements; whether this persistent mass deports itself like the alimentary canal, or whether after its destruction it retains the nuclei, must remain undetermined, nevertheless this same mass, which had composed the former organs, serves to build up anew the new ones. The products resulting from this destruction of organs are not wholly dispersed, but remain together and so receive the form of organs in their totality, even if no single histological element remain.

We must here leave undetermined how the cells which are to form the new organs originate, though this cannot be doubtful as regards the last two modes of development of the parts of the imago. They undergo a completely new development, *i. e.* of all those parts which are not generally present in the larva, or are not in their complete state of functional activity. In this last category belongs the thorax *and head of the fly and their appendages*, also those parts of the imago which arise from the disks;

also the *genital glands*. With a single exception all these parts are already formed in the egg, their cells also arise directly from the cells of the embryo, and in the upper prothoracic disks, which are afterwards formed, there is still a continuity between the embryonal cells and those of the disks if still indirect, through the mediation of the nuclei of the peritoneal membrane surrounding the tracheæ.

It is well to remark—and it is based on a grand plan in the development of the imago—that only the walls of the parts referred to arise from the formative disks, the skin alone and not the muscles. These last owe their origin to a new process of cell formation which generally obtains in the last half of the period of pupation, and gives the material for the development of the inner organs still wanting, the tracheæ, nerves, the fat body of the fly, and the genital armature. I have sought to call attention to the fact that we are dealing with a "free" cell formation, *i. e.*, that the newly formed cells arise directly or indirectly from cells. In the early part of these researches it was proved that the first cells in the fertilized egg show a process of free cell formation, arising independently from some previous formative element. An objection to this could be raised, that we have to do with an endogenous cell growth, while the whole egg should be considered as a cell. It is clearly shown to be in agreement with the earlier observations of Stein and Lubbock, that the insect egg is not the equivalent of a single cell, but is composed of a number of cells. Should this objection be laid aside, then a similar objection in the cell growth of the inner parts of the pupa could not arise, and if the relation be proved by fresh observations, then there may be a free cell growth in the living organism.

ENGLISH SPARROWS.

BY THOMAS G. GENTRY.

IN the September issue of the NATURALIST, Dr. Brewer reviews at considerable length a small article which appeared in a previous number, from the pen of Dr. Coues, concerning the European house sparrow. He accuses the latter of entertaining feelings of prejudice against the sparrows, and of being "apparently only too glad to condemn them on the scantiest evidence."

After a careful perusal of what Dr. Coues has written, I must confess that I am utterly unable to see how such a construction as Dr. Brewer's could be forced upon it. In the article to which reference has been made, Dr. Coues says, "I have always been opposed to the introduction of the birds, mainly on this score, also for other reasons." What the other reasons are, it is not my province to divine; but it is sufficiently obvious from a clause of the above quotation, that his opposition to them was not founded upon imaginary wrongs which he supposed they would commit, but upon knowledge either gained by personal observation or that had been communicated to him by others. He was undoubtedly in possession of evidence similar to mine, at the date of the latter's reception.

By referring to page 146 of the "Key," I find that he manifested considerable concern about the results which would evidently follow the overflowing of municipal limits by the species, when the latter should come in contact with our native birds. Here it is difficult to resist the conclusion, that the knowledge which he possessed at the time of writing the "Key," afforded a sufficient warrant for what he said, and furnished the ground for his anxiety. Dr. Coues is too careful an observer and recorder of facts to pen an article without having taken the precaution to intrench himself securely against assault. From the evidence submitted it is clear that the charge of prejudice which has been preferred against him, is not sustained.

Leaving the learned doctor to defend himself, in his own able manner, which I am assured he will not hesitate to do, a regard for my own feeble reputation, compels me to pen a few lines denunciatory of the charge of misrepresentation which Dr. Brewer has imputed to me, as implied in his review. The Doctor says in language not to be miscomprehended, that he "entirely discredits" my statement, assigning as the reason, that he does not believe that "the habits of either the house sparrow, or the robin, blue bird, or the native sparrows, are different in Pennsylvania from what they are in Massachusetts." What I see with the natural eye is evidence of belief. I am not prone to a state of "double vision," but generally observe things as they really exist.

I have never visited Massachusetts for the purpose of studying the habits of its birds, but have derived considerable knowledge thereof, from the writings of its ablest sons, and can fearlessly aver, that either they have failed to represent the facts as they found them, or else perceptible differences exist. I do not wish to be understood as imputing the charge of misrepresentation to them, but only to show that my experience in eastern Pennsylvania has been of such a character as to prove beyond dispute the existence of differences of habit. A multitude of circumstances exist to vary the habits of a species. A single circumstance occasionally suffices: but, generally, a combination is necessary to determine variation. The introduction of a new species in a given locality, in its struggle for existence, will often have a tendency to place a new aspect upon affairs. Rapidity of multiplication, and a consequent increase of numbers, will often make up for lack of individual courage;—for in union there is strength. Birds that are proverbial for courage will often betray feelings of cowardice, and yield when beset by fearful odds.

Ever since the introduction of the sparrows into our own city, I have been a close observer of their ways, and have watched their rapid increase and steady diffusion, with feelings of fear, lest coming into contact with our smaller birds, they would compel the latter to seek quarters elsewhere. This suspicion has been latterly confirmed. On the outskirts of Germantown, and even in the groves which surround many of our palatial residences, where the house sparrow has intruded, the robin, sparrows and blue bird, our most welcome guests, but occasionally greet us with their presence and voices. To be sure there are places where these denizens of foreign birth have not disarranged the quiet and harmony that once pervaded our groves and fields uninterrupted as they were save by an occasional breach of trust.

The members of a family that quarrel among each other will often exhibit the same unenviable trait of character towards outsiders. In the breeding season, Dr. Brewer admits that the males are exceedingly pugnacious, but only when actuated by amatory influence. Granting this for the sake of argument, is it not a reasonable presumption that while these influences endure, the passions being wrought up to a high pitch of excitement, the casual appearance of a stranger on the scene would be misconstrued as an act of interference, and the force of infuriated indignation be wreaked upon the innocent intruder. This would cause the former source of trouble to be forgotten for the time being; a feeling of love and good will to prevail, and the united strength of several to be centred upon an apparently common foe.

A supposed case of this kind would seem to admit of no other explanation. Here would be the starting-point for that enmity which I know to exist between this species and our smaller birds in certain localities. As years roll on it will gradually strengthen and increase. Just such facts as this supposed case calls for, in order to lead to a satisfactory conclusion, fell under my immediate observation during the early days of last spring.

Our smaller birds were just as abundant then, as in former years, and, as far as I was able to determine, the circumstances by which they were environed were materially the same. In places not as yet overrun by the house sparrows, apparently circumstanced similarly, our native species build as freely as ever. But there are spots not a few in number, where year after year I have wended in my ornithological pilgrimages, and returned with a rich harvest; but latterly, they have been deserted, and the familiar forms and voices I once loved to greet have gone, and strangers now occupy their loved retreats.

I have known instances where our smaller birds have commenced nest-building, and on the appearance of the sparrows have been compelled to beat a precipitate retreat.

What I have thus detailed at length, has been the experience of others. Mr. Abel Willis of Germantown informs me that the robins and sparrows were frequent visitors upon his father's premises in early spring, and were wont to build upon the bushes and trees that occupy the lawn, for several years in succession. This last year they came as usual, but the house sparrows had preoccupied all the available places. Displeased with such presumption, they were not disposed to yield quietly, but set about to expel the intruders; and in the encounter, being outnumbered, were obliged to emigrate to other quarters.

Repeatedly they renewed their endeavors, but were as often defeated.

In the cavity of an old apple tree in Mr. Willis's yard, a pair of the imported sparrows built a nest early in April last, since which time they have successfully reared three broods of birds, and were engaged in preparing for a fourth, when the stump which they occupied was severed from the trunk by the writer's request, and deposited in his collections. The birds were successful in bringing to maturity a family of twelve children. Mr. Willis informs me that the robins and sparrows were frequent visitors to the tree during the early part of the season, and their movements seemed to indicate a desire to build; but the coming of the house sparrows was the cause of a dispute in which the robins and our native sparrows were compelled to yield, and look for suitable quarters elsewhere. While engaged in nidification and incubation, he further informed me, not a bird is permitted to approach within ten paces of the nest, for the male is ever on the alert for intruders, and wreaks instant vengeance upon their temerity. The tree which held the nest being in close proximity to his residence, sitting within his back door, he could command a full view of the surrounding prospect, and observe every manœuvre of the sparrows. He had witnessed frequent encounters between the *innocent* sparrows and the robins and our native sparrows, and always noticed that the former were the aggressors. At the time of writing the sparrows still continue to visit the old apple tree, the scene of their former joys and pleasures.

The editor of the "Weekly Guide" of Germantown, last spring published the observations of several of our most prominent citizens, bearing upon this subject, in which were stated facts similar to what have been detailed. In the cases to which he referred, the sparrows were always the aggressive party, and what individual courage and strength failed to accomplish, was brought about through the medium of numbers. Instances were cited where the robins and blue birds were beset by numbers of the sparrows, and were completely banished from sites rendered dear and sacred by past associations and recollections. What our citizens particularly bewail is the utter repugnance which the sparrows manifest towards our smaller species. In certain localities referred to in the above publication, the sparrows had taken complete possession, and the familiar forms and voices of the song and chipping sparrows, the robin and blue bird, are recollections of the past, save when an occasional chirp bespeaks the presence of one of these friends, come back to take, perhaps, a last farewell of scenes which memory holds dear, to be instantly chased into obscurity.

Mr. John Strouse of Chestnut Hill, a careful observer of the habits of birds, a taxidermist by occupation, informs me that in all his experience, which has been a very long one, he never met a species which, for size, displayed such pugnacity and persistent pertinacity during the breeding period, as the house sparrow. Instances of these unenviable traits have repeatedly come under his immediate observation. There are localities, he affirms, known to him, where the robin, sparrows and blue bird, were wont to breed every spring, except the last, in great numbers. This neglect of accustomed sites he attributes to the quarrelsome nature of the sparrows. Upon the property of Mr. John Butler of Germantown, the smaller native species were always to be discerned in large numbers during the season of nidification, but now the English house sparrows have taken their places; the former were absolutely driven away, as he had ocular demonstration of the fact.

It is true that the birds have been of immense service in ridding our squares of the caterpillars which were once so prevalent and so annoying to persons of delicate nerves and refined tastes. Had our city authorities years ago, by a wise regulation, provided for the removal of the squirrels, and encouraged many of our smaller insectivorous birds to build, by erecting suitable boxes for their accommodation, and imposing the severest penalty upon any who should molest them, there is no doubt that we should have been saved the expense of importation and the repugnance which possesses some of us at witnessing the banishment of many of our most common species. Our smaller birds, once placed in our squares and unmolested, would, in course of time, come to regard such localities as their permanent homes, and, year after year, would revisit them under the spur of past associations. Innumerable instances might be cited to prove that birds are frequently so strongly attached to particular localities, that they visit them every season unless driven away perforce. Such being the case, why could not our squares be rendered so attractive to our smaller insectivorous birds that they would come to regard them as their homes during their sojourn with us? They could and the presence of the sparrows be dispensed with.

[We printed Dr. Coues note with much reluctance, believing that the introduction of the English Sparrow was an unmixed good. We make room for Mr. Gentry's reply, and *per contra* refer our readers to Mr. Gould's note on the English Sparrow in the present number of this journal.—EDS.]

REVIEWS AND BOOK NOTICES.

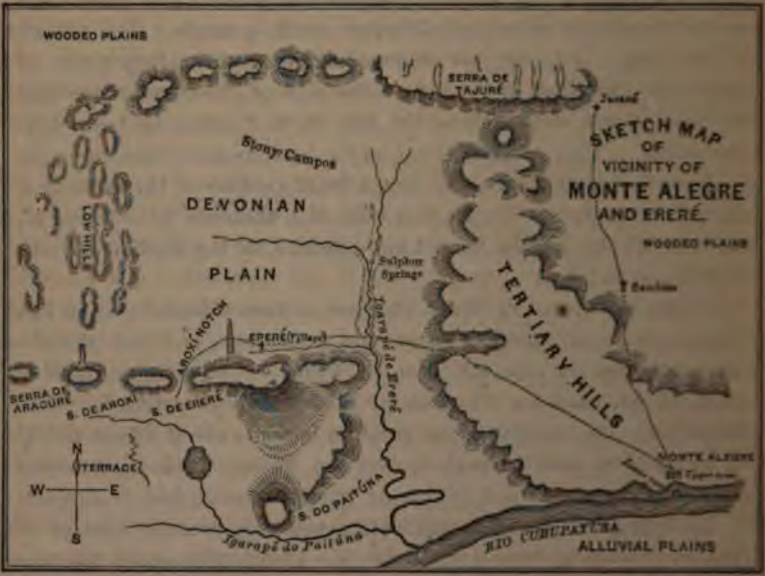
The Geology of the Lower Amazonas.[*]—*The Ereré-Monte-Alegre District and the Table-topped Hills.* In this paper Prof. Hartt has given us a very interesting account of a part of his careful explorations on the Lower Amazonas. In the fall of 1870, a month was spent in the vicinity of Ereré with three assistants, and in the following year, nearly as much time was given to the same neighborhood in company with Mr. O. A. Derby, his present assistant. A large portion of the ground was gone over on foot and field notes and sketches carefully made. The results of Prof. Hartt's labors are of extreme interest, as they clear up many uncertainties in regard to the age of the sandstones and shales of Ereré, supposed by the late Prof. Agassiz to be of glacial origin. They really belong as far back as the Palæozoic age. Space will permit us to give but a brief outline of the main portion of the paper, in connection with the sketches illustrating it, the cuts of which have been kindly loaned by the Buffalo Society of Natural Science.

To the northwest of Monte-Alegre, a town situated on the Rio Curupatúba, near where it enters the Amazonas, and distant 350–360 miles nearly directly west of Pará, is quite an extensive plain, surrounded on all sides by hills and high grounds. The distance across the plain from north to south is about fifteen miles, its width from east to west is over ten miles. It lies somewhat higher than the alluvial plains of the Amazonas, and is drained by the Igarapé of Ereré, a small stream flowing into the Igarapé of Paitúna, which in turn enters the Rio Curupatúba some distance below Monte-Alegre. The structure of the plain of Ereré is very simple, for it is composed of nearly horizontal strata of Devonian age, through which the small Igarapé has worn a little valley, narrow toward the north where the stream flows over the bare rocks, but broader below and partly filled in with alluvial deposits, lying below the level of the plain. The rocks project in low bluffs along the edge of the valley, and about fifteen feet in thickness of the Devonian beds are exposed, where the road from the

---

[*] Contributions to the Geology and Physical Geography of the Lower Amazonas. By Ch. Fred. Hartt, Professor of Geology in Cornell University. Bulletin of the Buffalo Society of Natural Science, vol. 1, No. iv, Jan., 1874, pp. 201-235.

Igarapé to Ereré crosses the bluff on the west. The beds composing the lower part of this bluff consist of a "soft, well-laminated, fine-grained shale, dark gray in color, alternating with white or red layers, and consisting of a fine, more or less sandy silt, with an abundance of little flakes of mica." One species of Discina and two of Lingula were obtained from the variegated shales. The former has been identified with a New York species, *Discina lodensis* of Hall from the Genesee shale, and is very abundant. Above the shales is a heavy bed of red and white clay rock, containing only obscure markings, the whole having a slight inclination to the southeast. In the northwestern part of the campo, Prof. Hartt found, that "the rock varies from a very hard, dark-colored, silicious shale, to a well-bedded, dark-gray, compact, cherty rock, breaking with a conchoidal fracture." These were the lowest beds of the series examined. Fragments only of fossils were obtained from the more shaly portions. Following the Monte-Alegre trail eastward from the igarapé, light-colored shales with thin bands of a reddish sandstone, full of fossils, are found just before reaching the Monte-Alegre highlands. The fossils belong to common Devonian genera. In a large open campo, to



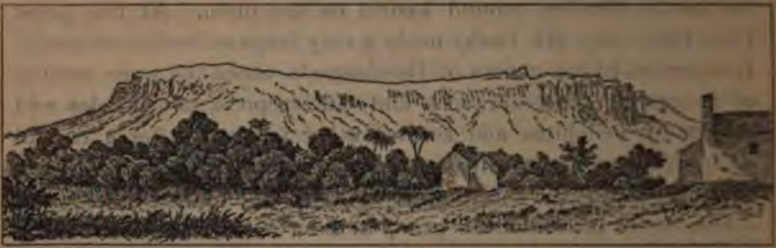
the north of the town of Ereré, at a distance of about two miles are red and whitish sandstones with whitish or yellowish shales. The sandstone is seldom seen *in situ*, but usually occurs in loose angular fragments. It affords an abundance of fossils, and forms the best collecting ground known on the plain. At this point Prof. Hartt and Mr. Derby made a very large collection of fossils. It represented ten genera of Brachiopods, about the same number of genera of Lamellibranchs and Gasteropods, two species and genera of Trilobites and several other forms. After a careful comparison of these with North American and European collections, several of the species were found to be identical with species occurring in the Hamilton group of New York, and described by Prof. Hall. So the conclusions are, that the sandstones and shales of the Ereré plain were formed at a period, corresponding to that in which the Hamilton shales were laid down, in North America.

The surface characters of the plain are in strict keeping with its simple structure. To the eastward of the Igarapé, it stretches to the foot of the Monte-Alegre highlands, almost as level as a floor, the Palæozoic rocks passing beneath the highlands. To the westward, as we approach Ereré, the plain forms a flat or rolling open campo, with long gentle ascents and descents. There is very little soil on any part of the plain, the surface of which is usually covered with angular fragments of red sandstone or rounded iron nodules. The campo is sparingly covered with grass, while the trees are few, stunted and scattered. Several large dykes occur on the plain.

Having gone over, though very hastily, what seems to be the most interesting part of Prof. Hartt's paper, as it is the richest in results, let us, by the aid of his sketches and descriptions, examine the surrounding hills. They form almost a square, protecting the level plain on all sides; to the eastward lie the Tertiary hills of Monte-Alegre, made up in large part of a single ridge, and extending from the Curupatúba on the south nearly to the Serra of Tauajurí on the north. They have a height of about 500 or 600 feet, are composed of horizontal beds of clays and sands, probably of Tertiary age, and seem to be "a degraded outlier of the once extensive formation of the serras of Parú." The upper town of the villa of Monte-Alegre is placed upon its summit, above the Rio Curupatúba, toward which the descent is very rapid.

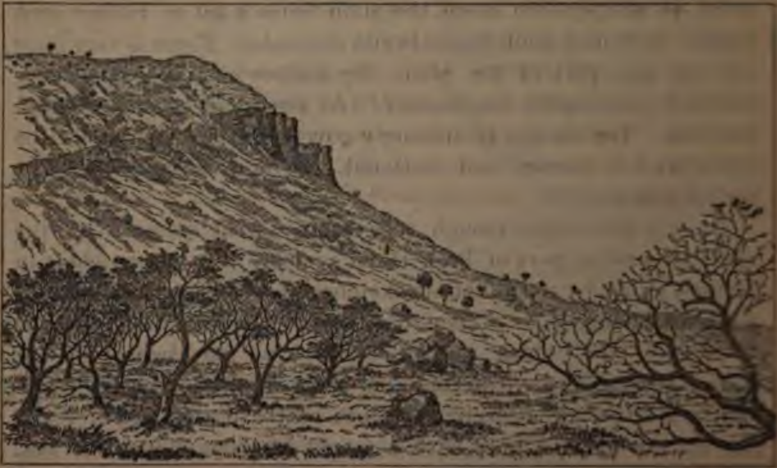
The Serra of Ereré forms a part of the southern boundary of the plain. On its east, between the serra and the igarapé, is a plateau, made up, at least in part, of obliquely laminated beds of tinted sands and clays. "The serra is a high, narrow, rugged, irregular ridge, four or five miles long, trending about east-north-east and west-south-west, and with abrupt and often precipitous sides." The top of the ridge is very irregular, composed of heavy beds of sandstone which are often exposed in ledges, or lie strewn about the surface in huge blocks. The sandstones form a line of bluffs along the upper part of the serra on its northern side, beneath which the slope is very rapid. At both ends the serra terminates

Fig. 93.



Serra of Ereré from the North.

Fig. 94.

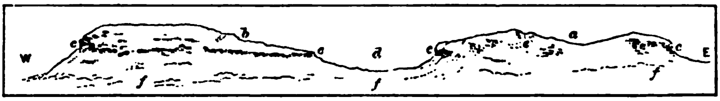


Serra of Ereré from the East.

quite abruptly, as represented in the following cut showing it from the east.

Just west of the Serra of Ereré is a short ridge, with the same trend and geological structure, called Aroxí. This is followed by several still smaller ridges, apparently part of the same outcrop.

Fig. 95.

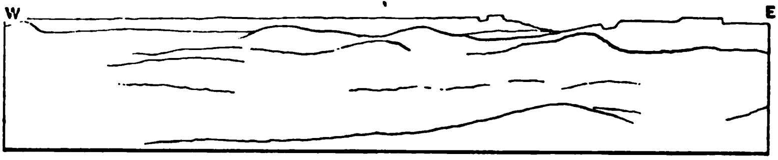


Serras of Ereré and Aroxí from the Southwest.

The Serra of Paitúna, near the igarapé of the same name, is composed of horizontal beds of the same sandstone as that of the Serra of Ereré, "so that the two serras probably form part of a synclinal fold." The sandstones forming the Serra of Ereré are well jointed and of unequal hardness. On weathering, they have assumed many curious forms, some of which are covered with Indian inscriptions and paintings. Fragments of silicified wood have been found in the stone, but they are too poorly preserved to admit of identification. Thus we have no palæontological evidence as to the age of these sandstones, which may be older or newer than those of the plain to the north.

Looking northeastward from the Serra of Ereré, beyond the northern termination of the Monte-Alegre highlands, we see the Serra of Tauajurí, a "splendid, blue, mountain mass, which, with precipitous front, heaves its back against the horizon, like a giant wave ready to break upon the level plains of Ereré, that lie spread out before us. While, northward from the hills (of Aroxí and Aracurí) stretches a belt of low, wooded ridges, skirting the campos on the west and north, and bending round to close the circuit with Tauajurí."

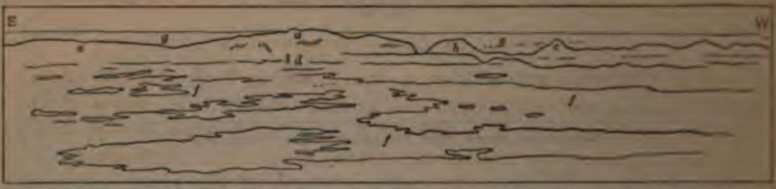
Fig. 96.



Sketch looking northward from Serra of Ereré.

The Serra of Tauajurí is a sharp-crested ridge, exceedingly steep on the southern side, but sloping off at an angle of 10°–15° on the northern. Its highest point is about 850 feet above the level of the sea, and it appears to differ entirely from Ereré in its geological structure. The view from the summit extends over an immense area, the entire Ereré-Monte-Alegre highlands and the Devonian plain being in sight.

Fig. 97.

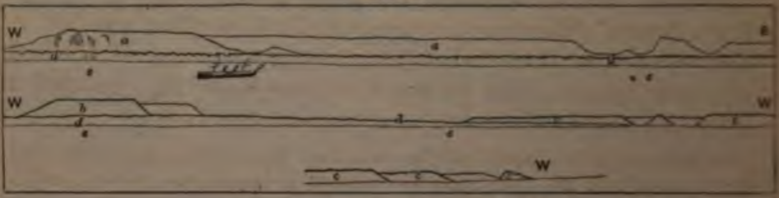


The Devonian Plain and Serras of Ereré from the Serra of Tauajurí.

The description of the table-topped hills to the eastward of Monte-Alegre, which have been the subject of much discussion, we copy verbatim:

"The table-topped hills of the Amazonas, so frequently described by travellers, consist of several isolated mountains or plateaus of circumdenudation composed of horizontal strata, which lie on the northern side of the river between Prainha and Almeirim, and known collectively as the Serras of Parú. They are characterized by their flat level tops and their very abrupt, sometimes precipitous sides. The westernmost of these serras is that of Parauáquára, eastward of which is that of Velha Pobre, while still farther east are the Serras of Almeirim. The general appearance of these mountains is represented in the following sketch made from the river."

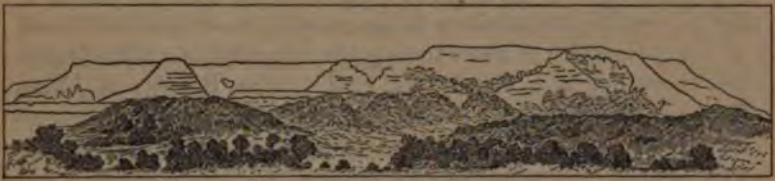
Fig. 98.



Serras of Parú from the Amazonas.

"The serra of Parauáquára is distant, as nearly as I can judge, about twenty miles to the eastward of the fazenda" (of L. J. Rodrigues on the Igarapé of Marapí). "It is an extensive, isolated plateau of circumdenudation, and apparently forms a long, narrow, irregular strip, running east–west. The following sketch, taken from a point a few miles west of the mountain, will show its topographical features as seen in elevation."

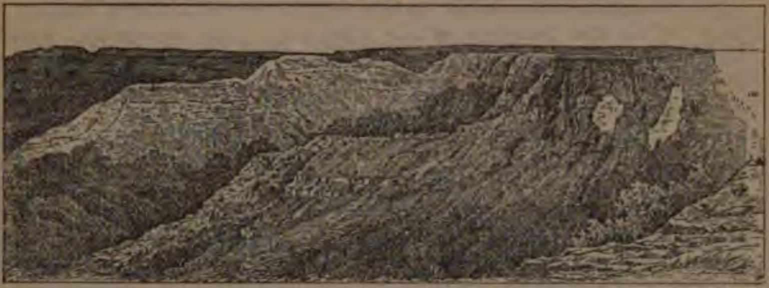
Fig. 99.



Serra of Parauáquára from the West.

"The following cut is from a sketch taken from the top of the serra, looking off northward along the western side, showing the level-topped summit, and the steep sides and spurs, along which run the edges of the horizontal strata like courses of masonry."

Fig. 100.



Serra of Parauáquára from the top looking northward.

No fossils have been found in the Parauáquára beds and their age is undetermined.—R. R.

We may add that the excellent palæontological work by Mr. Rathbun "On the Devonian Brachiopoda of Ereré, Province of Pará, Brazil," follows and supplements Prof. Hartt's paper, and is illustrated with three heliotypic plates, containing one hundred and one figures. The author draws the following conclusions from his study of the Brachiopod fauna of Ereré:—

> "Although the fossils so far obtained from Ereré, were collected from so small an area and so limited a thickness of rock as to render it unsafe to draw any extended or definite conclusions from them; yet the Brachiopod fauna, such as it is, resembles so closely that of the Hamilton group of New York state, as to leave no doubt that the beds in which it was found, the sandstones and shales of Ereré, represent about the same horizon as the Hamilton group of North America. Not only are characteristic Hamilton group genera found in the Ereré beds, but even species of those same genera, which cannot be separated from North American species of the Hamilton group."

THE ORIGINAL DISTINCTION OF THE TESTICLE AND OVARY.[*] — An interesting contribution to the germ layer or Gastræa theory of Haeckel, which is now exciting the attention of embryologists and evolutionists, is afforded by Prof. E. Van Beneden of Liége. It will cause an inquiry into the real value of Haeckel's Gastræa theory, disputed by some of our leading zoologists. We translate Van Beneden's introduction and conclusions.

"Huxley was the first who demonstrated that the entire organization of the zoophytes, medusæ, and polypes, hydroids and Siphonophores can be reduced to a sac formed of two adjacent cellular layers, the ectoderm and entoderm (Allman), and who considered this proposition as expressing the general law of structure in the zoophytes.[†] Although one did not dream at this period of seeking homologies between the vertebrates and lower animals, Huxley took in all the bearings of his discovery. He recognized and formulated in clear and precise language his opinion on the homology which he believed exists between the ectoderm and entoderm of the Cœlenterata, and the two primordial cellular layers of vertebrates. See in what terms he expresses this idea; 'the peculiarity in the structure of the body-walls of the Hydrozoa, to which I have just referred, possesses a singular interest in its bearings upon the truth that there is a certain similarity between the adult states of the lower animals and the embryonic conditions of higher organizations.

'For it is well known that, in a very early state, the germ, even of the highest animals, is a more or less complete sac, whose thin wall is divisible into two membranes, an inner and an outer; the latter, turned toward the external world; the former, in relation with the nutritive liquid, the yolk. . . . . The various organs are produced by a process of budding from one, or other, or both of these primary layers of the germ.'

He seeks likewise to establish a parallelism, from a histological point of view between the ectoderm of zoophytes and the external layer of the embryo of vertebrates on one hand, and the endoderm and internal layer on the other. He concludes by saying: 'thus there is a very real and genuine analogy between the adult Hydrozoon and the embryonic vertebrate animal.' All the embryological researches made in late years, in the first phases of the embryonic development of animals of all branches, have tended to confirm, extending it to the whole animal kingdom, the opinion of the illustrious English naturalist. And in the first rank of work done in this direction may, without fear of contradiction, be cited that of Kowalevsky; in showing the identity of development of Amphioxus and of the Ascidians, he closed with a single stroke the abyss, thought to be impassable, which separates the branch of vertebrates from all the lower organisms. The important publications of the same author on the other types of organization, added to those of Gegenbaur, Haeckel, Ray Lankester, Kleinenberg and some others, have resulted in extending to the entire animal kingdom this grand conception that all the parts of the animal organism are formed from the two primordial cellular layers, and everywhere homologous.

---

[*] De la Distinction originelle du Testicule et de l'Ovaire; Caractère sexuel des deux Feuillets primordiaux de l'Embryon; Hermaphrodisme morphologique de toute Individualité animale; Essai d'une Théorie de la Fécondation. Bruxelles, 1874. 8vo, pp. 68.

[†] Observations upon the Anatomy of the Diphydæ and the Unity of Organization of the Diphydæ and Siphonophoræ. Proceedings Royal Society, 1849.

These ideas have just been developed in detail and brilliantly defended in two essays of a high philosophic import. Haeckel has proposed in his brochure *Die Gastræa theorie, die phylogenetische Classification des Thierreiches und die Homologie der Keimblätter*, a theory which he had first announced in his monograph on the calcareous sponges. Some analogous ideas, and in several respects almost identical, have been published in England in the Annals and Magazine of Natural History, under the title; "On the Primitive Cell-layers of the Embryo as the Basis of the Genealogical Classification of Animals" by my friend E. Ray Lankester.

All the pluricellular animals, in which the development begins by the segmentation of the cell-egg, pass through in the course of their evolution a similar embryonic form, that of a sac whose thin walls are constituted of two adjacent layers; the endoderm and ectoderm. The first surrounds a cavity which is the primordial digestive tube; the second limits exteriorly the body of the embryo; it alone can be impressed by external causes. The digestive cavity communicates with the exterior by a single orifice which serves both as mouth and anus. The embryo is reduced to a digestive cavity, which is but a simple stomach; Haeckel has proposed to give to this primordial form the name of *Gastrula*. As this embryonic form occurs in the vertebrates, as well as the mollusks, arthropods, echinoderms, worms and polypes, it is clear that the ectoderm is homologous in the different types of organization; that the endoderm has in all the same morphological value; that the primordial digestive cavity of vertebrates, and that of all other types of organization have the same anatomical signification. The existence of this common form in the course of evolution of all the metazoal animals allows us to refer them to a common source; there is a convergence of the great types of organization and not a parallelism as had been urged by Cuvier and Von Baer. Finally, we can infer the existence at a geological epoch far back, of organisms like the Gastrula form; these organisms, probably varied in a thousand ways in their form and in their external characters, have been the common source of vertebrates, arthropods, mollusks, echinoderms, worms and zoophytes; they constitute the very numerous group of Gastræades (Haeckel).

If the endoderm and ectoderm are homologous in all the Metazoa [*i.e.* all animals except Protozoa] we then have a right to suppose that these two cellular layers have in all the same histological value, and that the same systems of organs are developed in the different types of organization from the same primitive layers. This induction has been already freely confirmed in that which concerns the central nervous system, which is developed in all animals from the ectoderm.

Consequently, it makes no difference if we should wish to know the origin of an organ, whether we seek for it in one or another type of organization; the results can be extended to the whole animal kingdom, and receive a general signification.

However, of all the types of organization, that which serves best for research on this capital question of the origin of organic systems, is that of the polypes, still called zoophytes or Cœlenterates. In them, in short, the ectoderm and endoderm persist with their embryonic characters during their entire life; all the organs of the zoophytes are only a dependence of one or the other of these layers, sometimes of the two layers united.

The polype form may be traced back with the greatest facility to the Gastrula, all the parts of which are preserved without undergoing any great modifications during all the course of existence.

Conclusions. In the Hydractiniæ 1. The eggs are developed exclusively from the epithelial cellules of the endoderm. They remain, up to the time of their maturity, surrounded by the elements of the endoderm.

2. The testicles and spermatozoa are developed from the ectoderm; this organ results from the progressive transformation of a primitive cellular fold formed by invagination.

3. There exists in the female sporosacs a rudiment of the testicular organ; in the male sporosacs a rudiment of an ovary. The sporosacs are then morphologically hermaphrodites. * * * * Fecundation consists in the union of an egg, a product of the endoderm, with a certain number of spermatozoa, products of the ectoderm. This act has no other end than to unite chemical elements of opposite polarity, which, after having been united an instant in the egg, separate again; for in most animals those in which the division of the vitellus into two occurs, the elements from which the ectoderm are formed are already separated from those which are to form the internal layer of the embryo.

The new individuality is realized at the instant when the union between the elements of opposed polarity has taken place, as absolutely as a molecule of water is formed by the union of atoms of hydrogen and oxygen."

In a late paper on the embryology of jelly fishes Metznikoff has criticised the universal application of Haeckel's Gastræa theory, and shown that in the embryos of the Acalephs and Echinoderms the *outer* layer is invaginated and forms the walls of the stomach. And it appears to us that if organs, such as the ovary and testicle, almost universally recognized as homologous, are developed from opposite germ-layers, then the importance of the germ-layer theory of Haeckel is diminished by Van Beneden's remarkable discovery. We should say, however, that at the last meeting of the French Association for the Advancement of Science, Mr. P. Hallez questioned whether the ovary and testis were homologous. Meanwhile Giard announced at the same meeting that the male organs of *Sacculina*, a crustacean, are developed from the frontal glands, which in turn arise from the ectoderm.

MAPS OF WHEELER'S EXPEDITION.—We have received six advance sheets of a "Topographical Atlas" projected to illustrate Explorations and Surveys west of the 100th meridian of longitude, embracing results of the different expeditions under Lt. Wheeler, Corps of Engineers, U. S. A., published by the war department. The scale of each atlas sheet is one inch to eight miles. Sheet 50 covers portions of central and western Utah; sheets 58 and 59 embrace parts of eastern and southeastern Nevada and southwestern Utah; sheet 66 covers portions of southwestern Utah, northwestern Arizona and southeastern California. The work appears to be well done and will be useful to geographers and naturalists studying the distribution of plants and animals, especially the map of the areas of drainage to the Atlantic and Pacific oceans and of the interior basins of the United States, west of the Mississippi river.

We have found exceedingly useful the progress map of lines and areas lying west of the 100th meridian, and giving the lines of exploration by different parties sent out by government since Lt. Pike's expedition of 1805; not, however, including the area surveyed by parties under the Department of the Interior and Smithsonian Institution.

A large number of sheets are in preparation, and we shall ere long with the aid of these and the maps publishing by Hayden and Powell's expedition, with those of Whitney's Survey of California, be in possession of definite knowledge of the region west of the Mississippi, which is now altogether wanting in any atlas we have yet seen.

Physiology of the Circulation.*—In this useful work the author has aimed "at producing a comprehensive view of the circulation as it exists in the lowest vegetable and highest animal forms." He has "endeavored to prove by a variety of arguments that the circulation, whenever and wherever found, differs less in kind than in degree; that fluids may move in living tissues with or without vessels and hearts; that the circulation in an aggregation of vegetable cells is essentially the same as that which occurs in the tissues of our own bodies. As a chain is composed of links, all of which are formed on a common type and fit into each other, so the circulation in the lowest vegetables and animals gradually develops into that of the higher, until we reach man himself; the circulation in the one being relatively as perfect as in the other."

Bulletin of the Cornell University.†—The first two numbers of this new periodical, a credit alike to the university and the officers, contains a report of a reconnoissance of the Lower Tapajos river, by Professor C. F. Hartt, and a finely illustrated paper by Mr. O. A. Derby on the Carboniferous Brachiopoda of Itaitúba, Rio Tapajos, Brazil. We hope the patrons of the University will sustain this valuable publication.

Manual of Metallurgy.‡—The author of this excellent manual was a student of Dr. Percy, the distinguished metallurgist, from whose work the present one is in part compiled. It will evidently prove, as the author hopes, a useful auxiliary to the more voluminous works on this subject. It is amply illustrated.

BOTANY.

Insectivorous Plants.§—The leaf of Sarracenia is a trumpet-shaped tube, with an arched lid, covering, more or less completely, the mouth. The inside is furnished with a perfect *chevaux-de-frise* of retrorse bristles, commencing suddenly about an inch from the base; thence decreasing in size until from about the middle to the mouth they are so short, dense, and compact, that they form a decurved pubescence which is perfectly smooth and velvety to the touch, especially as the finger passes downward. Under the hood again, many of them become large and coarse. Running up the front of the trumpet is a broad wing with an emarginate border, parting at the top and extending around the rim of the pitcher. Along this border, but especially for a short distance inside the mouth, and less conspicuously inside the lid, there exude drops of a sweetened, viscid fluid, which, as the leaf matures, is replaced by a white, papery, tasteless, or but slightly sweetened sediment or efflorescence; while at the smooth bottom of the pitcher is secreted a limpid fluid possessing toxic or inebriating qualities.

---

* The Physiology of the Circulation in Plants, in the Lower Animals, and in Man. By J. Bell Pettigrew. Illustrated by 150 engravings on wood. London. Macmillan & Co. 1874. 8vo, pp. 329.

† Bulletin of the Cornell University. (Science.) Vol. 1, Nos. 1, 2. Ithaca, N. Y., 1874. 8vo, pp. 63, with 9 plates.

‡ A Manual of Metallurgy. By W. H. Greenwood. Vol. I. Fuel, Iron, Steel, Tin, Antimony, Arsenic, Bismuth and Platinum. Illustrated by 59 engravings. New York. G. P. Putnam's Sons. Advanced Science Series. No date. [1874] 12mo, pp. 200. $1.50.

§ Abstract of a paper read at the Hartford meeting of the Amer. Assoc. Adv. Science.

The insects which meet their death in this fluid are numerous, and of all orders. Ants are the principal victims, and the acidulous properties which their decomposing bodies give to the liquid doubtless render it all the more potent as a solvent. Scarcely any other Hymenoptera are found in the rotting mass, and it is an interesting fact that Dr. Mellichamp never found the little nectar-loving bee or other Mellifera about the plants. On one occasion only have I found in the pitcher the recognizable remains of a *Bombus*, and on one occasion only has he found the honey bee captured. Species belonging to all the other orders are captured, and among the larger species I have found katydids, locusts, crickets, cockroaches, flies, moths, and even butterflies in a more or less irrecognizable condition.

Two species are proof against the siren influences of the destroyer, and in turn oblige it, either directly or indirectly, to support them. The first is *Xanthoptera semicrocea* Guen., a little glossy moth which may be popularly called the Sarracenia moth. It walks with perfect impunity over the inner surface of the pitcher, and is frequently found in pairs within the pitchers soon after these open in the early part of the season, or about the end of April. The female lays her eggs singly near the mouth of the pitcher, and the young larva from the moment of hatching spins for itself a carpet of silk, and very soon closes up the mouth by drawing the rim together with a delicate gossamer-like web, which effectually debars all small outside intruders. It then begins fretting under the hood, feeding downward on the cellular tissue and leaving only the epidermis, and by the time the worm has attained its full size the pitcher generally collapses. At this time the worm is beautifully colored, and is characterized by rows of tubercles, which are especially prominent on the four larger, legless joints. The chrysalis is formed in a very slight cocoon. The species, kindly determined by Mr. A. R. Grote, was many years ago figured by Abbot, who found it feeding on *Sarracenia variolaris* in Georgia. Guenée's descriptions were made from these figures, and here the author appends a few descriptive notes from the living material, of interest only to specialists on account of their technical character. The second insect which successfully braves captivation is a species of flesh-fly which the author names *Sarcophaga sarraceniæ*. After giving some technical details of structure, he shows how the larva of this fly riots in the putrid insect remains, and how, in order to undergo its transformations, it bores through the leaf and burrows into the ground. The immense prolificacy of these flesh-flies, and the fact that the young are hatched in the ovaries of the parent before they are deposited by her on tainted meat, are duly commented upon, as well as the rapid development of the species; also the propensity of the larvæ for killing one another and their ability to adapt themselves to different conditions of food-supply are made appreciable.

In conclusion the author says: To one accustomed to seek the why and wherefore of things the inquiry very naturally arises as to whether Xanthoptera and Sarcophaga play any necessary or important rôle in the economy of Sarracenia. Speaking of the Sarcophaga larva, Mr. Ravenel asks, "May he not do some service to Sarracenia as Pronuba does to Yucca?" And if so may not all this structure for the destruction of insects be primarily for his benefit? Can he be merely an intruder, sharing the store of provision which the plant, by ingenious contrivance, has secured for itself, or is he a welcome inmate and profitable tenant? Self-fertilization does not take place in Sarracenia, and the possibility that the bristly flesh-fly aids in the important act of pollination, lends interest to the facts. No one has witnessed with greater pleasure than myself the impulse which Darwin has of late years given to such inquiries, but the speculative spirit, is, in some quarters, becoming too wild and unbridled, and we should be cautious lest it impair our judgment or our ability to read the simple lesson of the facts. My own conclusions summed up are:

First: There is no reason to doubt, but every reason to believe that Sarracenia is a truly insectivorous plant, and that by its secretions and structure it is eminently fitted to capture its prey.

Second: That those insects most easily digested (if I may use the term), and most useful to the plant, are principally ants and small flies, which are lured to their graves by the honeyed path, and that most of the larger insects, which are not attracted by sweets, get in by accident and fall victims to the peculiar mechanical structure of the pitcher.

Third: That the only benefit to the plant is from the liquid manure resulting from the putrescent captured insects, some of which doubtless descend to the root-stalk, and probably through large tubular cells, observed by Mr. Ravenel, passing through the petiole into the root.

Fourth: That Sarcophaga is a mere intruder, the larva sponging on and sharing the food obtained by the plant, and the fly attracted thither by the strong odor, as it is to all putrescent animal matter or to other plants, like *Stapelia variegata*, which give forth a similar odor. There is nothing to prove that it has anything to do with pollination, and the only insect that Dr. Mellichamp has observed about the flowers with any frequency, is a Cetoniid beetle — the *Euryomia melancholica*.

Fifth: That Xanthoptera has no other connection with the plant than that of a destroyer, though its greatest injury is done after the leaf has performed its most important functions. Almost every plant has its peculiar insect enemy, and Sarracenia, with all its dangers to insect life generally, is no exception to the rule.

Sixth: That neither the moth nor the fly have any structure peculiar to them, which enables them to brave the dangers of the plant, beyond what many other allied species possess. — C. V. RILEY.

DISTRIBUTION OF AMERICAN WOODLANDS.*— This is a paper to be published in the Statistical Atlas of the United States, now in progress of publication. It is an exhibition of a map, and a description of the methods by which the map was colored. Then follows an analysis of the trees of the tree flora in the ten districts into which the United States was divided. The flora of the United States, the author said, is believed to contain over 800 woody species, and over 300 trees. Of these trees about 250 species are somewhere tolerably abundant, about 120 species grow to a tolerably large size, 20 attain a height of 100 feet, 12 a height sometimes of over 200, and a few — perhaps 5 or 6 — a height of 300. The speaker analyzed the districts, adding: New England I consider to contain 80 or 85 species, of which 50 may reach a height of fifty feet; Maine is the great source of pine and spruce lumber, but as a whole the hard wood species predominate. Without going into the details of this flora, it is sufficient to give the author's remark that the area of woodland in New England is not perhaps greatly diminishing, but the amount of timber capable of being made into sawed lumber is lessening. The Middle States have about 100 to 105 species of trees, 65 to 67 of which sometimes reach 50 feet in height. Here were originally very heavy forests. There are still large areas heavily timbered, but the timber for all purposes is unquestionably rapidly diminishing, and there is no compensating influence going on for increase.

---

*Read at the Hartford Meeting of the Amer. Assoc. Adv. Science.

But in the Middle and New England States various hard woods attain their greatest perfection as to strength and durability; and as a consequence here we find the manufactures that are dependent on those woods. In the southeastern region — that is, extending from Virginia and Florida — we have about 130 species. In each case these form the conspicuous elements of the landscape. 75 attain a height of 50 feet or more, and about a dozen species a height of 100 feet. A belt of pine timber extends the whole length of this region, which is the great source of the hard and yellow pine. The author described the ornamental trees of that beautiful region, and resumed: The northwestern region, from Ohio to Minnesota, and north of the Ohio River, is represented by about 105 to 110 species, 68 or 70 of which may reach a height of fifty feet. That is the district furnishing at present the largest production of sawed lumber within the United States. Michigan alone furnished in 1870 of the 12,750,000 of M. feet, 2,250,000; Wisconsin furnished over 1,000,000 — the two states thus producing more than one-fourth of the whole yield returned in that year.

The author alluded to the rapidity of the destruction going on in that region; also of the diminution of sawing lumber in the forests, and the increase in woodland over the prairie region as it becomes cultivated. The southwestern region, extending from

Kentucky to Texas and the Gulf, has about 112 to 118 species, 60 or 65 of which attain a height of 50 feet, which the author also analyzed. West of these last two districts, this treeless belt, extending entirely across the continent from the Gulf of Mexico to the Arctic Ocean, is described, and its characteristics within the limits of the United States are mentioned. It is 350 miles wide in its narrowest part, between latitude 36° and 37°, and 800 miles wide on our northern border. The Rocky Mountain region is next considered. This consists of from 28 to 30 species, but a vastly smaller number making up the timber region. Perhaps not over half a dozen species constitute by far the larger part. No hard woods are abundant in any of the forests west of the Great Plains, although hard woods occur, particularly in the southern and western part, as scattered trees rather than as forests. Between the Rocky Mountains in the Sierra Nevada is a desert or sparsely wooded region, which extends southward to Mexico, uniting on its southern part with the treeless expanse which extends from the Atlantic to the Pacific along our southern frontier, and throwing out a spur entirely across the Rocky Mountains near the Pacific Railroad, connecting it with the treeless plains on the eastern side. This great treeless district varies very much in its different regions, has quite a large number of species of interest to botanists, and some few of economic value. The only forests within it are forests of coniferæ, occurring on the mountains, of which the largest one is in Arizona and is 400 miles long, the limits of which have recently been demonstrated by Lieut. Wheeler's Expeditions. Here followed an analysis by the author of the flora of the region west of this Desert; of California, Washington Territory, and Oregon, where were found the grandest forests, perhaps, on earth, and the noblest trees. The number of species of these latter is quite large, but in any one region the number of species is small. With one single exception all of the trees within the United States which attain a height of 200 feet are found in this district. The forests are entirely of cone bearing trees and the number of species is large, the number of timber trees being very large and their size and value also being great. In Washington Territory official reports state that the land will produce from 25,000 to 300,000 feet per acre, and that there are vast tracts "that would cover the entire surface with cord wood

10 feet in height." Then follows again an analysis of the trees of California and Oregon, including the many forms there that have been of interest in the world.

In Alaska, the tenth region or district, the data are insufficient for the map, but there are heavy forests there that are well known. The author rapidly discussed the original disposition of forests, showing what variety of causes have controlled this. Then the economic value of some of the industries directly dependent on them were alluded to, and the author ended his paper with some conclusions regarding the future supply, and suggestions regarding the planting of trees.—WM. H. BREWER.

ADOXA MOSCHATELLINA L., IN IOWA !—A correspondent in the Northeastern part of the state sent me some time since specimens which prove to be *Adoxa Moschatellina* L. Its locality is given in the "Flora of North America" as between lat. 54° and 64°, and on the higher peaks of the Rocky Mountains as far south as lat. 42°. Professors Porter and Coulter in the "Flora of Colorado" call it a "sub-alpine, common" plant. The last named gentleman collected it on Mt. Lincoln at the altitude of 13,000 feet. Mr. Watson in a private note says, "not found before this side of Colorado and the mountains, I believe."

Its occurrence in Iowa is certainly unlooked for. It grows abundantly on a rocky hillside, and was in bloom in May. Its locality in this case is best given as "Upper Iowa River, Iowa." —C. E. BESSEY, *Agricultural College of Iowa*, Aug. 31, 1874.

DISPERSION OF SEEDS BY SHOOTING THEM OFF. — Our correspondent, Mr. Brandegee of Colorado, writes: —

"While drying seeds of *Ionidium lineare*, I noticed an interesting habit it has of shooting its seeds. Each capsule contains six seeds and is a six shooter. The three valves open wide and press the seeds tightly by their margins and in this way they are shot off singly, as one shoots orange seeds from between the fingers. A good shot will go fifteen to twenty feet."

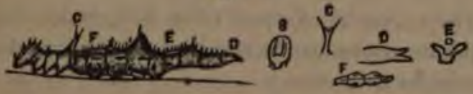
All violets do it, and *Ionidium* is of this family. To render the operation clearer, it should be added that the three firm valves into which the capsule splits, after their separation fold together on their axis, to which the seeds are attached in a row, and it is the gradually increasing pressure so applied to the hard and smooth-coated ovoid seeds that fires them off. — EDS.

BOTRYCHIUM LUNARIA Swartz, was collected in Michigan long before the date given in the June NATURALIST by Mr. Gillman. In my herbarium are specimens collected on Isle Royale by Dr. A. E. Foote, in the summer of 1868.—C. E. BESSEY.

ZOOLOGY.

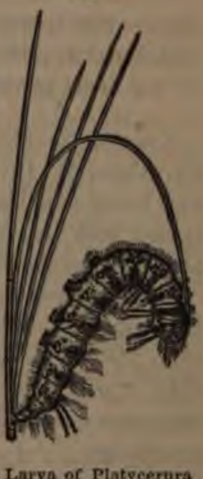
TRANSFORMATIONS OF OUR MOTHS.—Some interesting notes are given by Mr. J. A. Lintner in the "Twenty-sixth Annual Report on the New York State Cabinet of Natural History for 1872." He describes very fully the larva of *Eudryas unio* which feeds on *Epilobium coloratum*, and not on the grape, as stated by Fitch, and afterwards by Packard and Riley on Fitch's authority. Lintner gives characters for distinguishing the larvæ of *Eudryas unio* and *grata* as well as *Psychomorpha epimenis*, which so closely resembles Eudryas in its larval stage. The larvæ of *Parorgyia parallela* Gr. Rob., *Apatelodes angelica* Grote, *Cœlodasys unicornis* (Sm. Abb. Fig. 101), *Platycerura furcilla* Pack. (Fig. 102), *Dryocampa rubicunda* Fabr., *Tolype Velleda* (Stoll), *Nadata gibbosa* (Sm. Abb. Fig. 103), and an unknown Notodonta (Fig. 104, Fig. 105, the same when feeding); also of *Cerura borealis* Boisd. (Fig. 106) and other Bombycid moths are described. Several

Fig. 101.



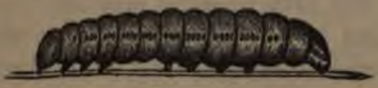
Larva of Cœlodasys unicornis.

Fig. 102.



Larva of Platycerura furcilla.

Fig. 103.



Larva of Nadata gibbosa.

Fig. 104.

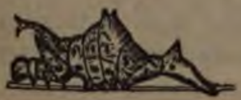
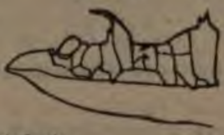


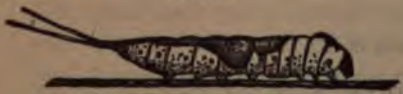
Fig. 105.



Larva of Notodonta.

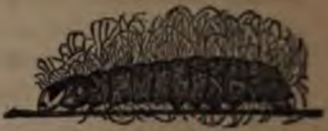
larvæ of the Noctuidæ are also described for the first time; among them *Diphtera deridens* Guenée (Fig. 107). Several new moths are described, among them *Cucullia Speyeri* (Fig. 108, male; Fig. 109, female). The separate copies are in some cases accompanied by the finest photographs we ever saw.

Fig. 106.



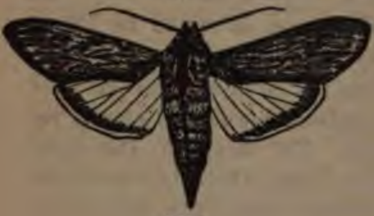
Larva of Cerura.

Fig. 107.



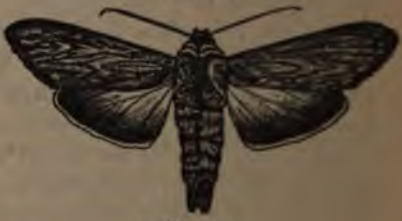
Larva of Diphtera deridens.

Fig. 108.



Male.

Fig. 109.



Female.

Cucullia Speyeri.

English Sparrow.—I noticed in your magazine for September Dr. Thos. M. Brewer's defence of the European house sparrow, and being convinced that this little friend of man has been maligned both in its native and adopted home, I desire to add my testimony as the result of careful experience and observation.

In January last I procured twelve European house sparrows in Boston, Mass., and had them sent to me by express. Two died from the effects of the journey, the rest I kept in my barn loft until April, when they were let out, or rather eight of them, as two more were killed by a cat which got in the barn without my knowledge.

On our place we have a large number of pear and peach trees, besides several maples, two walnut trees, an English oak and shrubs and flowering bushes of various kinds. In our kitchen garden we raised during the past season three kinds of corn, potatoes, cabbages, tomatoes, beets, carrots, onions, radishes, strawberry tomatoes, horse radish, celery, several varieties of beans, peas, squashes, pumpkins, turnips, martynas, lettuce, spinach, and other vegetables, besides herbs, black, red and white currants, and several varieties of grapes; we also had a large number of flowers. During the summer our garden has been remarkably free from worms, and our crops never were better. Our trees never did better, while they have been remarkably free from caterpillars where last year (1873) they were nearly stripped of their foliage by their ravages.

In the place of the eight sparrows let out in April we now have thirty, and they appear to be constantly at work about the place. They are nearly always accompanied by the American goldfinch or yellow bird and our common sparrow.

To-day as I sat in my room writing I saw them fraternizing with a flock of blackbirds on one of our walnut trees. In fact they seem to court the society of other birds, and never have the birds been so abundant on our place. The male sparrows fight among themselves after the manner of roosters, but do not seem to molest other birds.

The sparrows did, with the yellow birds, attack our radish and turnip seeds as they ripened, but by using netting around those plants we kept the birds from doing serious damage. Nothing else was attacked by them, and we consider them a positive benefit to our place. We keep a horse and are accustomed to spread the stable droppings from day to day, broadcast. The sparrows seem to watch for this, and in an incredibly short time pick over and separate the manure and spread it much better than could be done with the hoe and rake. They are sprightly, friendly, and useful, and we would not have them leave us for much more than they originally cost.—STEPHEN GOULD, *Newport, R. I., Sept.*, 1874.

MONSTROSITIES AMONG BEETLES.—Dr. Kraatz publishes, in the 17th volume of the Berliner Entomologische Zeitschrift, an illustrated paper on deformities in beetles.

GEOLOGY.

SUPPOSED LOWER SILURIAN LAND PLANTS.—Prof. J. S. Newberry doubts (American Journal Science and Arts, August, 1874) whether the Sigillaria mentioned by M. Lesquereux as occurring in the Lower Silurian beds of Ohio is a Sigillaria at all or whether it is a land plant even.

European Fossil Cetacea.—Prof. J. F. Brandt has published, in the memoirs of the Royal Academy of St. Petersburg, an elaborate quarto work on the fossil and sub-fossil Cetacea of Europe. It is illustrated with 34 plates.

ANTHROPOLOGY.

Restoration of Indian Pottery.—The caving of a bank of loamy earth on the east side of Connecticut River, about seven miles above Hartford, brought to light, several years ago, fragments of Indian pottery, which were found by a gentleman then temporarily residing at East Windsor Hill in that vicinity. They were composed of burnt clay intermingled with particles of pounded quartz, and as they evidently had a relation to one another, he commenced putting them together, using for that purpose slips of writing paper, about half an inch wide, and two inches long, coated with thick gum-arabic mucilage, and stuck on the inside of the pieces opposite the joints.

When I first saw his work he had reconstructed, from the pieces which he had found, about half of a kettle, the rim of which was entire, and about ten inches in diameter, and quite elaborately ornamented with lines grooved in the clay while it was in a plastic state. I was much interested in his work, for though I had frequently found fragments of that kind of pottery, I had never seen pieces of any one utensil sufficient in size or number to indicate the forms or dimensions of such ware. I went with him to the place of deposit, and we raked and sifted the soil thoroughly, and recovered additional fragments, from which we built up with the gummed slips, the entire form of the kettle, although there were in several places gaps which no shards were found to fill. It cost a deal of time and study to locate all the pieces, of which there were about seventy-five in number broken (it might almost be said) into every shape and size into which crockery could be broken. The labor was like that of putting together a dissected map, *very dissected;* or like that of solving all the figures of a book of Chinese puzzles laid together in one grand design.

The gummed slips answered the purpose of their designer admirably. Had he interposed between the shards any kind of cement, that would have prevented strict contiguity, or that would have set them immovably in their places as they were added one by one, it would have been impossible to go on without trimming pieces that would not otherwise enter their proper places. Every additional piece trimmed would have aggravated the errors of adjustment, and the original form of the kettle would have been lost. But the paper slips, pasted and interlaced only on the inside of the work, allowed close adjustment of joints. They were also flexible, and capable of removal at any point by wetting if the progress of the work demanded. The fragments were pretty uniformly one-quarter of an inch in thickness, and it was sometimes, though not often, necessary to shore them up with props until the slips were sufficiently dry to hold them. The kettle was rebuilt resting on its rim, mouth downward, and in that position the fragility of the reconstruction made it necessary to keep it. The form developed was egg-shaped, the small end of the egg representing the bottom of the kettle, and the large end opening into a short, wide neck, which flared into a bell-shaped rim. The ornamental grooving was principally on the neck and rim; though the whole remaining exterior surface was chopped with short grooves intersecting at various angles. A cross section at any point did not vary very noticeably from a circle. The interior showed prints made by fingers in moulding and smoothing the plastic clay, and towards the bottom, the wear of subsequent use. The exterior of the bottom was somewhat darkened, as if by smoke; there was no glazing, and the general color was a dark brick red. The dimensions nearly were, height fourteen and one-fourth inches, diameter of rim nine and one-half inches, of neck eight and one-fourth inches, and of body eleven and one-half inches. Capacity about thirteen quarts, beer measure.

The first finder of the relic shortly transferred his residence to a foreign country, and his title to me. Wishing recently to take a drawing from this kettle, I found that atmospheric changes had caused most of the gummed slips to peel from the interior of the work so that it scarcely held together. Chaos might come again at any moment. As a first precaution I immediately made a quantity of duplicate numbers on little squares of paper, and gummed them on the outside opposite all the joints; then separated the work into nearly its original number of pieces, and rebuilt it with new slips, leaving a hole at the top (or bottom rather, as the kettle stood mouth downwards) large enough to see, and work upon, the interior.

After the body of the kettle had been brought into its true shape, the first step towards improvement was to make a not very thick solution of glue in water, and lay it with a small brush, into all the joints; avoiding spreading the glue beyond the joints as much as possible. This, on drying, set all the fragments in place quite firmly. The upper pieces around the hole, however, were not glued, but left supported by the gummed slips only for convenient insertion of the last pieces. Slips were next gummed on the inside across all gaps left by missing fragments. I then made a kind of cement, or mortar from pieces of very soft burned brick, pounded to dust, sifted, shaded to the color of the kettle with lamp-black, and moistened to a plastic state with not very thick glue water. With this mortar all the joints and gaps were filled on the outside. But the gaps were designedly not filled quite to the required thickness with one coat, as the mortar would shrink and crack somewhat in drying. Wherever these cracks appeared, glue was rubbed into them with the brush before laying on the final coat of cement. When this coat was dry it was smoothed with old files and sand paper and groove-marked in imitation of the unbroken surface. Protuberances in the cement too large to be readily filed down in a dry state, were first surface-softened by slight damping. The hole at the top was next underlaid with slips, and filled. Finally the slips were all removed from the interior by damping with a moist cloth, and any crevices that appeared were filled with cement.

From a basket full of nearly worthless shards was thus reconstructed a single relic, very rare (at least in Connecticut) whole and strong, showing no obvious breakage, as good as new for ethnological use, and as indestructible if not soaked with water, as any specimen of ceramic art.—E. W. Ellsworth, *East Windsor Hill, Ct.*

MICROSCOPY.

Beaded Silica Films.—Mr. Henry J. Slack has produced delicate films of silica, by mixing powdered glass, powdered fluor spar and sulphuric acid in a flask and conducting through a glass pipe the gas which escapes from the heated mixture into a dish containing glycerine and water. By contact with pure water the gaseous silica is deposited so suddenly and violently as to produce only amorphous particles, and a similar result is obtained when silica is precipitated from its alkaline salts or water-glasses dissolved in water; but a mixture of glycerine retards the process and gives opportunity for the formation of definite forms. The films thus produced, washed and examined in water or mounted in balsam, either simulate organic cell forms, with cavities formed by the bursting of minute gas-bubbles, or consist of beads or spherules exhibiting remarkable regularity of size and arrangement; the beads seem to vary from $\frac{1}{30000}$ to $\frac{1}{100000}$ inch or less; and they appear to least advantage, in size, under the highest powers. They seem calculated to add to our knowledge of high power definition if not to throw light upon questions of crystallization and organization. Some of the films produced the beautiful polychromatic effects so often mentioned by Dr. Pigott as occurring in beaded diatoms and scales.

CELL-CULTURE IN THE STUDY OF FUNGI.—Ph. Van. Tieghem and G. LeMonnier in their published researches on the Mucorini give a good working account of their method of cell-culture which is applicable not only to the smaller fungi but to many other plants. A glass cell $\frac{1}{5}$ or $\frac{1}{6}$ inch is cemented upon a glass slide, and a suitable cover-glass is kept in place by three minute drops of oil placed on the edge of the ring. The contained air is kept moist by a few drops of water placed in the bottom of the cell, while a very small drop of the nutritive fluid is placed on the lower surface of the cover-glass, and in this drop the spore to be cultivated is sown. The whole drop, and indeed the entire contents of the cell, can now be examined with suitable powers, and the germination and development of the plant traced hour after hour from any given spore, with the greatest certainty and ease. Extraneous spores will sometimes be introduced, but they are easily detected.

HANDLING DIATOMS.—Capt. Lang, of the Reading Microscopical Society, gives "A useful Hint" to persons who select and arrange diatoms and pursue similar minute work under the microscope. Hairs, from various animals, whipped on to delicate handles, are generally satisfactory, those of the badger, or fine camel-hair or sable brushes, being generally useful. But some diatoms refuse to be thus picked up, and these he finds to be readily handled by means of a fine feather. The fine, stiff, elastic, and sharply pointed feathers on the extreme end of the carpal joints of the wings of the golden plover and of the woodcock were found to be especially suitable.

REPRODUCTION OF DESMIDS.—Prof. Leidy, at a late meeting of the Academy of Natural Sciences of Philadelphia, made some remarks on the mode of reproduction and growth of the Desmids. In illustration he described a common species of Docidium or Pleurotænium. This consists of a long cylindroid cell constricted at the middle and slightly expanded each side of the constriction. When the plant is about to duplicate itself the cell-wall divides transversely at the constriction. From the open end of each half-cell there protrudes a colorless mass of protoplasm defined by the primordial utricle. The protrusions of the half-cells adhere together and continue to grow. The bands of endochrome now extend into the protrusions and subsequently keep pace with their growth. The protrusions continue to grow until they acquire the length and form of the half-cells from which they started. The exterior of the new half-cells thus produced hardens or becomes a cell-wall like that of the parent half-cells. In this condition two individuals of Docidium are frequently observed before separation. During the growth of the new half-cells the circulation of granules in the colorless protoplasm is quite active. In a species of Docidium $1\frac{1}{2}^{mm}$ long by $\frac{1}{16}^{mm}$ broad, the growth of the new half-cells was observed to be at the rate of about $\frac{1}{3}^{mm}$ in an hour.

ANGULAR APERTURES.—It is not yet forgotten that at the London examination of the $\frac{1}{6}$ inch lens sent to demonstrate the possibility of obtaining an excessive angular aperture in immersion work on balsam objects, the lens was measured at an adjustment of which nothing to the point was known except that it was not a position of immersion work at all, nor a recognized maximum position for any kind of work; the plain fact being that the accomplished committee were so bent upon teaching us the familiar fact of reduced angle that they seem to have forgotten to look for any other possibility in the case. Nor is it likely to be forgotten as long as Mr. Wenham so far forgets his usual and admirable caution as to allude to the correction of this palpable mistake as an "after quibble," nor while the eminent President of the Royal Microscopical Society utters in his formal address such an astounding statement as the following:—"The lens in this instance was properly corrected as a dry lens, and then after measurement in air it was measured in water and then in very fluid Canada balsam without alteration of the adjustment. It may be quite possible that if the lens had been readjusted so as to give the best image for immersion in balsam, a slightly greater angle might have been obtained; but this would not have been a fair way of making a comparison as it is not the mode in which the glass would ever be employed in actual practice." By not saying squarely, *It is probably true that if the lens had been readjusted so as to give the best image for immersion in water, a greater angle would have been obtained; and this would have been the fair way of making the measurement, as it is the mode in which the glass would be employed in actual practice,* Mr. Brooke lost a rare opportunity to do a noble if not a generous act. As he is well known to be incapable of an intentional sophistry which by adroitly worded phrase should suggest a doubt where none is felt, belittle the concessions which are called for by manifest truth, and say one thing which is true but has no relation to the case at issue, and at the same time imply another thing which does relate to the case but is unqualifiedly incorrect, there is no choice but to conclude that his extraordinary statement, notwithstanding its tone of judicial coolness, was made without that deliberation which the official character of the address demanded.

On the other hand a still more recent lens by the same maker, claiming still more excessive aperture, has been examined by Mr. Wenham by his method of cutting off false light described in the August number of the NATURALIST. By this method, which would seem incapable of excluding any image-forming rays, he succeeded in obtaining a clear and distinctly limited angle for the lens whose light, when not thus protected, was vague and uncertain; the angular aperture at the same time being reduced from "180°" to "112°" which corresponded within a few degrees with the aperture computed trigonometrically from the width of the front lens and the length of the working focus. To this it is answered that with a dry object on the cover there is *no* distance involved and the triangle is impracticable; while accurate focussing upon a stop which is feasible at "uncovered" adjustment, is liable to error from spherical aberration when adjusted for maximum angle. Mr. Tolles' method of demonstrating the utilization of extra-limital rays is by placing a central stop upon the posterior surface of the back system of lenses, so large as to cut off all light when the objective is used dry; so that by no trick of illumination can the light be made to pass through the narrow ring of clear aperture remaining around the stop; but if water be flowed in both above and below the balsam-mounted object, converting both the objective and the illuminating semi-cylinder into immersion arrangements, a well lighted and defined image is immediately produced. With regard to extreme angles in connection with dry objects, Mr. Tolles claims that his much-disputed $\frac{1}{6}$ inch does actually form an image with the most oblique rays that can impinge upon the slide, all other rays being cut off by a card or shutter which can be moved up close to the bottom of the slide.

A FINDER FOR MICROSCOPES WITH PLAIN STAGE.—A writer in "Science Gossip" advises a horizontal line ruled across the centre of the stage from side to side. Vertical lines are ruled across this an inch each side of the centre. A large label, say nine-tenths of an inch square, is fixed to each end of the slide. When the object is in position these labels are marked with lines or dots to correspond with the stage-lines below, and by these can easily be returned to the same position on the same stage or any stage ruled exactly to match. Several objects may be indicated on the same slide by as many marks, and a memorandum preserved recording which marks indicate each object; thus 4-7 or $\frac{4}{7}$ records that the object is indicated by the fourth vertical and the seventh horizontal dot or line.

THE RIGHT-ANGLED PRISM AS A SUBSTITUTE FOR THE MIRROR FOR TRANSMITTED LIGHT.—Mr. Ingpen uses an achromatic doublet, plano-convex, which can be placed when desired close to one side of the right-angled prism for transparent illumination, thus making the prism available as a substitute for both plane and concave mirrors, while the usual form where the condensing lenses are balsamed to the prism is useless for giving parallel light.

APPARATUS FOR GIVING PRESSURE TO OBJECTS WHILE DRYING.—Though spring clips of various kinds are chiefly employed for this purpose, yet a more compact and controllable arrangement is sometimes preferred. A mounting board is often arranged to hold the slides while pressure-rods tipped with cork rest upon the cover-glasses and give the required pressure; these rods being held in a vertical position by being passed through loops of wire or through a couple of perforated shelves one above the other, while they are pulled down with the required degree of force by elastic bands passing over or through them and fastened to hooks or rings below. Such an apparatus, figured and described in "Martin's Manual of Microscopic Mounting," p. 28, is inconvenient chiefly by reason of the difficulty of varying pressure by means of the elastic band. Mr. C. E. Hanaman suggests the employment, as a substitute for the rods, of glass tubes loaded with shot or mercury so as to give the required pressure by their weight. By merely uncorking the tube and pouring a little mercury in or out all necessary changes of pressure may be secured, or the different tubes may be kept filled to different heights and the proper one chosen in each case.

THE NEW TYPE PLATE.—Möller has brought out another of his exquisite plates. This time he photographs, upon the centre of a glass cover, a square of about one-sixth of an inch composed of eighty circles surrounded by a black background with the name of a different diatom photographed under each circle. In the centre of each circle is mounted a diatom corresponding to the label below, two specimens being often introduced to show different views of the same form; of course all is arranged in inverted position on the slide, but under the microscope appears as described. The objects are mounted between two thin glasses which are set in a brass plate three and a quarter inches long and one and a quarter wide.

FIXING DIATOMS.—Mr. J. K. Jackson, in a communication to "Science Gossip" laments that the best "diatomaniacs" hold so tightly the secret of their mounting, and details his own experience for the assistance of others. The diatoms are carefully cleaned and a dip of the material containing them evaporated on a slip which is then placed under a 1½ inch objective. The covers on which to mount have been previously glazed with gum by putting on the centre of each, carefully cleaned, a small drop of a solution formed of an ounce of freshly distilled water and five or six drops of a freshly prepared solution of gum tragacanth or arabic; a number of covers being prepared at once on a wooden rack and dried over a hot plate in order to leave the least possible opportunity for exposure to the "vile inappreciable dust" of the room. With a hair from a cow's neck, mounted in a wooden handle, a diatom is picked out from the dip, at the rate of from eight to ten per minute and disengaged from the hair by dabbing it on the glazed cover. When sufficient have been thus transferred to form a device, as a star, cross, initials, etc., they are placed under the 1½ inch, and with the hair they are, with patience as well as tact, pushed, coaxed and driven into the required position, taking care to leave the valves on their backs to avoid insurmountable trouble with air bubbles. The objects are then fixed by bringing them close to the mouth and moistening by a long slow breath. After drying again on the hot plate they may be freely mounted in balsam which may even be boiled if desired and the mounting finished at once. Only on the calmest of days can sufficient immunity from dust be obtained for successful work; and the care of the eyes should never be forgotten during this straining work.

THE PODURA SCALE.—Mr. Charles Brooke, in his President's Address before the Royal Microscopical Society, gives the following cool and excellent criticism on this much debated subject. "The writer, reviewing this subject under the dictates of common sense, when observing the familiar Podura notes of admiration well defined and free from colour, cannot resist the inference that in the objective all aberrations are nicely balanced, and the object truly represented in the visual image; on the contrary, when the same-object is viewed as rows of ill-defined beads loaded with colours, it is difficult to avoid suspecting that the appearance is a spectral illusion, resulting from some unexplained diffraction or interference; and this suspicion can hardly be dispelled from his mind by anything short of rigid mathematical demonstration."

NOTES.

Mr. JOHN E. GAVIT, President of the American Note Company of New York, died at his residence, Stockbridge, Mass., on the 26th of August, in the fifty-eighth year of his age. It is rare that one finds in the busy walks of life a man who, while filling an office demanding constant attention, unlimited resource of invention, executive ability and diplomacy as well, should yet find time to familiarize himself with the various branches of science, not only understanding them thoroughly, but capable of appreciating and discussing their bearings with those specially engaged in the subject. Of a man of such varied attainments, one would naturally ask, why he had not published the results of his work,—had not made known his inventions. Various reasons may be given: first the unceasing and continuous demands of his business rendered it impossible for him to carry on an uninterrupted line of investigation. Above all things he abhorred the hasty publishing of novelties. In this respect he was perhaps hypercritical.

Nothing could be too complete for him, and to this demand on his part for as near approach to absolute perfection as possible, the country is indebted for the exquisite work presented by the Bank Note Company of which he was chief executive officer.

His power to detect merit was noteworthy, and many a young man can look back to Mr. Gavit for the incentive first given him to work, and to thank him too for placing the standard to be attained high above that level aimed at by most workers. While his science came in as a relief from his business duties, one was surprised to hear him converse freely on such diverse subjects as architecture and deep sea explorations, fertilization of flowers, geology, and the whole range of biological science.

To hear him was not to listen to what any intelligent man might know regarding such topics, but it was to gather the latest views and to hear something new. In fact one could never talk with him without seeing old facts placed in a new light and new facts added.

Mr. Gavit was best known as a microscopist, his collection of stands, objectives, and other apparatus being one of the finest in the country.—E. S. Morse.

It will be remembered that Capt. Hall went as far north as 82° 16′. This has been exceeded by two Austrian explorers, Payer and Weyprecht, who penetrated into the frozen sea north of Siberia and discovered two hundred nautical miles north of Nova Zembla a mountainous country with glaciers and some vegetation and game, which they named Francis-Joseph Land. This was about one thousand miles in length so far as observed, and the northernmost point reached was Cape Vienna in latitude 83°.

A lobster farm, as we learn from "Nature," has been established near Boston. On the seaward side it is closed by banks, having hatches or sluices so as to admit of the flow and ebb of the tide. Last summer about 40,000 lobsters of all sizes were deposited in this ground. In the winter 15,000 fine lobsters were sold. We should be glad to hear of the further success of this important undertaking.

"The Sandwich Naturalist Association" was recently organized at Sandwich, Illinois. The following officers were elected :— Nahum E. Ballou, M. D. *President*, Prof. A. E. Bourne, *Secretary*, and Frank M. Webster, *Treasurer*.

There is a new floorcloth, said to be made of ground cork and glue on a foundation of canvas, which would be an economical substitute for sheet cork for lining insect boxes.—Egbert Bagg, Jr., *Utica, N. Y.*

The famous geologist, M. Elie de Beaumont, recently died in Paris at the age of 76. In 1856 he was made Perpetual Secretary of the French Academy, succeeding Arago.

BOOKS RECEIVED.

Till Algernes Systematik. By J. G. Agardh. 1872. pp. 71. 8vo.

The Physiology of the Circulation. By J. Bell Pettigrew. London, 1874. pp. 402. With plates. 8vo.

Beskrifning öfver Besier-Ecksteins Kromolitograf och Litotypgraf. By Algernon Bortzell. Stockholm, 1872. pp. 23. With plates. 4to.

Bidrag till kannedomen om Sveriges erratiska bildningar. By Otto Gumælius. Stockholm, 1872. pp. 20. With plates. 8vo.

Öfversigt af de geologiska forhallandena vid Hallandsas. By David Hummel. Stockholm, 1872. pp. 585-613. With map and cuts. 8vo.

Ueber die Geognosie der schwedischen Hochgebirge. By A. E. Tornebohm. Stockholm, 1873. pp. 60. With map and cuts. 8vo.

Contributions to the Geology and Physical Geology of the Lower Amazonas. The Erere-Monte-Alegre District and the Table-Topped Hills. By Ch. Fred Hartt.

On the Devonian Brachiopoda of Erere, Province of Para, Brazil. By Richard Rathbun. Morgan Expeditions, '70-'71. Buffalo, 1874. pp. 201-261. With plates. 8vo.

Description de la formation carbonifere de la Scanie. By Edouard Erdmann, Stockholm. 1873. pp. 87. With maps and cuts. 4to.

Annuaire de la Societe Americaine. Paris, 1873. pp. 153-200.

Om nagra forsteningar frau Sveriges och Norges "Primordialzon." By J. G. O. Linnarsson. Stockholm, 1873. pp. 789-796. With plates. 8vo.

Les livraisons de la Carte Geologique de la Suede. Nos. 46-49. Stockholm, 1873. With cuts. 8vo.

Magnetische und Meteorologische Beobachtungen. By Carl Hornstein. Prague, 1873. pp. 94. 4to.

Annales de la Societe Entomologique de France. Paris, 1873. Tome troisieme. pp. 504. With plates. 8vo.

Bulletin Mensuel de la Societe d'Acclimatation. Paris. 1874. pp. 123. 8vo.

Die Ausstellung der Geologischen Landes-unterzuchung Schwedens. Wien, 1873. pp. 34. 8vo.

A Manual of Metallurgy. By William Henry Greenwood. G. P. Putnam's Sons, Publishers. New York, 1874. Vol. I. pp. 260. Illustrated. 8vo. $1.50.

An Introduction to the Study of General Biology. By Thomas C. MacGinley. G. P. Putnam's Sons, Publishers. New York, 1874. pp. 200. 8vo. 75 cts.

Geological Survey of Indiana. By E. T. Cox. Indianapolis, 1874. pp. 494. With plates and maps. 8vo.

Palæozoic Fossils. Vol. ii, Part I. Geological Survey of Canada. By E. Billings. Montreal 1874. pp. 144. With plates. 8vo.

Bulletin of the Buffalo Society of Natural Sciences. Buffalo, 1874. Vol. ii, No. 2. pp. 105-144. With plate. 8vo.

Report on the Dredgings in the Region of St. George's Banks in 1872. By S. I. Smith and O. Harger. pp. 57. With plates. 8vo.

Societe Entomologique de Belgique. Serie II. No. 2. Aug. 1, 1874.

Jenaische Zeitschrift fur Naturwissenschaft. Jena, 1874. viii Bd. N. F. I Bd. 2. With plates. pp. 177-336. 8vo.

Fifty-sixth Annual Report of the Trustees of the New York State Library. Albany, 1874. pp. 185. 8vo.

Twenty-third and Twenty-fifth Annual Report on the New York State Museum of Natural History. Albany, 1873. With plates. pp. 252. 8vo. 25th Report and plates. pp. 123. 8vo. 1874.

Notes on American Lepidoptera with Descriptions of Twenty-one New Species. By Aug. R. Grote. 1874. (Bull. Buf. Soc. Nat. Sci. pp. 145-163.) 8vo.

Determination of the Species of Moths Figured in the "Natural History of New York." By Aug R. Grote. 1874. (Bull. B. S. N. S. pp. 164-168.)

Infant Diet. By A. Jacobi, M. D. Revised by Mary Putnam Jacobi, M. D. G. P. Putnam's Sons, Publishers. New York, 1874. pp. 119. 8vo. 75 cts.

The Transit of Venus. By George Forbes. Macmillan & Co., Publishers. London and New York, 1874. Illustrated. pp. 99. 8vo. $1.25.

THE

AMERICAN NATURALIST.

Vol. VIII.—DECEMBER, 1874.—No. 12.

IMBRICATIVE ÆSTIVATION.

BY A. P. MORGAN.

1. THE arrangement of the different parts of the flower in the bud is called *æstivation* or *præfloration*. Æstivation has reference chiefly to the relative arrangement in the bud of the sepals and petals. The æstivation of the floral envelopes passes by several gradations from the regular alternate arrangement of leaves, in which the parts are situated at different heights one above another, to the complete whorled arrangement in which the parts are all placed at the same level, edge to edge.

2. There are distinguished three principal kinds of æstivation denominated respectively the *imbricative*, the *contortive* and the *valvular*. The latter presents no variety except the infolding of the edges of the leaves which, however, does not concern their relative arrangement in the bud; and contortive æstivation exhibits no variation except in the direction of the twist which may be either from left to right or from right to left. It is our purpose to give an analysis of imbricative æstivation and to endeavor to systematize its variability.

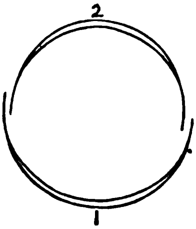
3. *In imbricative æstivation some parts of the floral whorl overlie others like shingles on a roof: that is, certain parts are wholly external while others are wholly internal.* There is usually a more or less evident spiral arrangement of the parts; the spiral making one or more turns to form the whorl. When the direction of the

---

Entered, according to Act of Congress, in the year 1874, by the PEABODY ACADEMY OF SCIENCE, in the Office of the Librarian of Congress, at Washington.

spiral in all the flowers of plants of the same kind is uniformly from left to right or with the hands of a watch, the parts of the whorl may be termed imbricate +; when the direction of the spiral is uniformly from right to left or contrary to the hands of a watch, the parts are imbricate —. If, however, the spiral does not maintain a uniform direction, but winds in some flowers of the plant to the right and in others to the left, the parts of the whorl may be termed imbricate ±.

Fig. 110.



4. Imbricative æstivation is the most common arrangement of both sepals and petals. It admits of much variety dependent upon the number and the relative position of the external and internal parts. Also, this variety of arrangement is displayed much more in the corolla than in the calyx.

5. In a dimerous imbricate whorl, the two edges of one part overlap both edges of the other part (Fig. 110), as in the calyx of the Spring Beauty (*Claytonia Caroliniana*). This is an alternate two-ranked arrangement.

6. In a trimerous imbricate whorl, one part is wholly external, one is wholly internal and the third is intermediate, that is, has one edge in and the other edge out, as in the calyx and corolla of Trillium. Here there is an obvious spiral arrangement and the successive members of the cycle may be numbered 1, 2 and 3.

Fig. 111.

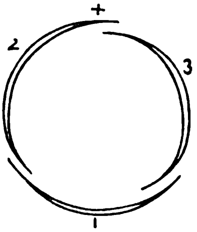
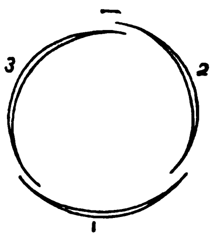


Fig. 112.



The spiral makes a single turn to the right or to the left according as 3 lies to the right or left of 1, and the whorl is imbricate + (Fig. 111), or imbricate — (Fig. 112), accordingly. This is the 3-ranked or $\frac{1}{3}$ arrangement of leaves.

7. A tetramerous imbricate whorl presents two cases. In the

first case two opposite parts are wholly external, and the other two opposite parts are wholly internal (Fig. 113), as in the calyx of cruciferous flowers. This is the case of opposite decussate leaves. In the second case one part is external, one internal, and

Fig. 113.

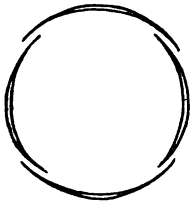


Fig. 114.

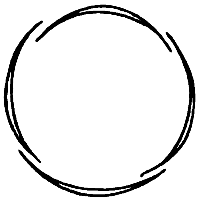


Fig. 115.

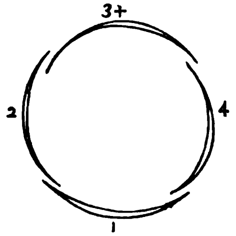
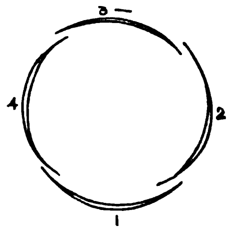


Fig. 116.



the other two intermediate. In this case there are two varieties, according as the internal part is opposite or adjacent to the external part. When the internal part is adjacent, there is an evident spiral arrangement. Numbering the parts 1, 2, 3 and 4,

Fig. 117.

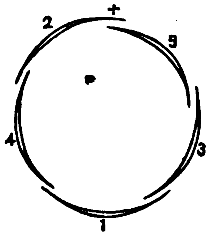
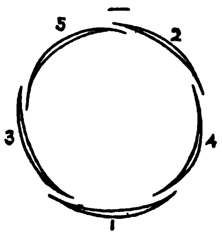


Fig. 118.



the spiral makes one turn to the right (Fig. 115), or to the left (Fig. 116), according as 4 is on the right or left of 1. This is the common arrangement of the petals of cruciferous flowers. The internal part may sometimes be seen opposite (Fig. 114) in the same flowers; this is the arrangement of the four sepals of the White Water Lily (*Nymphæa odorata*).

8. A pentamerous imbricate whorl, also, presents two cases.

I. Two parts of the floral whorl are external, two parts are internal and one is intermediate (Figs. 117, 118). This is regular pentamerous imbrication. It corresponds to the quincuncial or ⅖ arrangement of leaves. The spiral makes two turns to form the whorl. The successive members of the cycle may be numbered 1, 2, 3, 4 and 5 (Figs. 117, 118). 1 and 2 are the external parts; 4 and 5 are the internal parts; and 3 is the intermediate part. 1 has 3 and 4 adjacent and 2 and 5 opposite. One edge of 3 is covered by the adjacent edge of 1, while the other edge of 3 overlaps the adjacent edge of 5. The succession of the numbers of the cycle in the whorl, in one direction, is 1, 4, 2, 5, 3; in the other direction, 1, 3, 5, 2, 4. 3 shows the direction of the spiral; when it lies on the right of 1, the spiral winds from left to right, and the parts of the whorl are imbricate + (Fig. 117); when it lies on the left of 1, the spiral winds from right to left, and the parts are imbricate — (Fig. 118).

II. One part of the floral whorl is external, one part is internal and three parts are intermediate. This is irregular pentamerous imbrication. There are two varieties of this case, according as the internal part is opposite or adjacent to the external part.

Fig. 119.

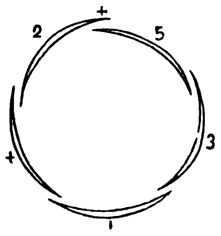
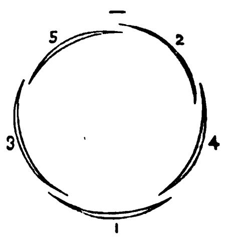


Fig. 120.



When the internal part is opposite (Figs. 119, 120) there is still a spiral cycle of two turns; but the part 4 by a slight torsion, throws out one edge over the adjacent edge of 2; so that 2 and and 4 have one edge out and one edge in, the same as 3: 3 lying between 1 and 5 still shows the direction of the spiral. This is the æstivation of papilionaceous flowers. In these the large petal called the vexillum or banner overlaps the others, and on this account this variety has been termed *vexillary* imbrication. This variety of imbrication, however, occurs frequently in the flowers of many plants along with the regular imbrication, as shown in the examples of *Rubus odoratus* and *Pyrola elliptica* (Tables I and II). When the internal part is adjacent to the external part

Fig. 121.

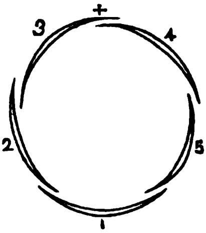
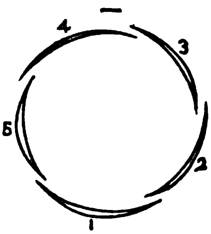


Fig. 122.



(Figs. 121, 122), the spiral makes but a single turn to form the whorl. The direction of the spiral is shown by 5 lying on the right or on the left of 1. This second variety is perhaps to be met with only as a casual variation from the other modes. I know of no flowers in which it is the only mode of æstivation, but the extent to which it occurs in many flowers is shown by the example of *Rubus odoratus* (Table I).

Fig. 123.

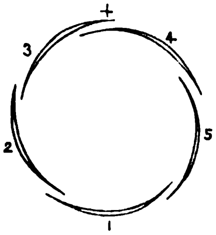
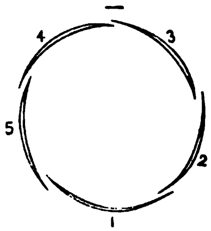


Fig. 124.



9. The second variety of irregular imbrication passes easily into contortive æstivation by 5 throwing out one edge over 1. This also is shown by some of the flowers of *Rubus odoratus* passing into the contorted mode.

10. The imbrication of the flower sometimes shows a fixed relation to the axis, and whether there be such a relation or not, needs to be carefully observed. When the inflorescence is definite the flower terminates the axis and of course there is no other relation. Hence the position of the external and internal parts is

immaterial in diagram. When the inflorescence is indefinite, however, the external petal sometimes maintains a fixed relation to the axis. For instance, in papilionaceous flowers, the external petal is always the posterior one. In the violet the external petal may be either the right or left upper petal, the lower spurred petal being always internal. In many plants on the contrary, some of the flowers commence the spiral at one part of the whorl, and other flowers at other parts of the whorl. This is shown by the example of *Pyrola elliptica* (Table II.)

11. For the purpose of observing and recording the mode of imbrication in a pentamerous flower for example, rule a table as follows (Table I):

In the Table, I denotes the first case or regular imbrication; II denotes the second case or irregular imbrication; while 1 and 2 indicate the first and second variety of II. Each example is marked by the direction of the spiral. Summing up the observations of 100 flowers of *Rubus odoratus*, examined for the illustration of this article, they show the following variety of arrangement:

Calyx, imbricate.
Case I. + 54, — 46. Total, 100.
Corolla, imbricate.
Case I. + 22, — 10. Total, 32.
Case II.
1 v. + 14, — 13. Total, 27.
2 v. + 20, — 13. Total, 33.
Corolla, contorted,
+ 4, — 4. Total, 8.
Total + 60, — 40.

TABLE I.

Rubus odoratus L.

No. of Spec.	Calyx, imbricate.			Corolla, imbricate.		
	I	II		I	II	
		1	2		1	2
1	−				+	
2	−					+
3	+				−	
4	−				−	
5	+			−		
6	+					−
7	+				+	
8	+			+		
9	+				−	
10	+					+
11	−					+
12	−				+	
13	−				−	
14	+			+		
	+					−

[*TABLE II.*] CASE I.

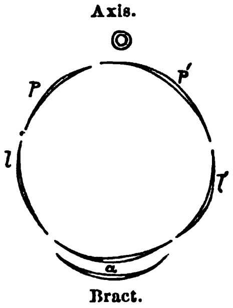
No.	1	2	3	4	5
3	l	p'	a	p	l'
12	l	l'	p	a	p'
18	l'	l	p'	a	p
4	l'	p	a	p'	l
16	p	l'	l	p'	a
2	p	a	p'	l	l'
3	p'	a	p	l'	l
3	p'	l	l'	p	a
10	a	p	l'	l	p'
CASE II. 1.					
4	l	l'	p	a	p'
1	l	p'	a	p	l'
5	l'	p	a	p'	l
1	p	l	l'	p	a
2	p	a	p'	l	l'
2	p'	l	l'	p	a
2	p'	a	p	l'	l
5	a	p'	l	l'	p
CASE II. 2.					
3	l'	p'	p	l	a
3	l	a	l'	p'	p
1	a	l'	p'	p	l

12. For the purpose of observing and recording both the imbrication of the whorl and the relation of its parts to the axis, I make a diagram of the flower (Fig. 125) and rule a table as on the opposite page (Table II):

In this diagram of the corolla of *Pyrola elliptica* (Fig. 125) *p* and *p'* denote the upper or posterior petals; *l* and *l'* the lateral petal; and *a*, the anterior or lower petal.

In Table II the figures 1, 2, 3, 4, 5 represent the successive parts of the spiral. The Table shows the summing up of one hundred observations of the imbrication of the corolla of *Pyrola elliptica* Nutt.

Fig. 125.



THE METAMORPHOSIS OF FLIES.[*] III.

BY DR. AUGUST WEISSMANN.

WHAT appears most unusual in the development of the Muscidæ is the genesis of the thorax and head together with their appendages. That this section of the fly's body is completely formed anew, not standing in genetic connection with the corresponding parts of the larva, contradicts the generally accepted and long prevalent view, according to which pupation is only a moulting process. As little does this opinion agree with the fact of the total transformation which all the inner organs suffer during pupation. All the systems of the organs of the larva die, in part completely, in part cell by cell, in order afterwards to be built up anew.

Evidently the metamorphosis of Corethra stands in diametrical opposition to this mode of development, and indeed to the two previously described main points. Here the pupation may be rightly regarded as a moulting process; we see no phenomena ac-

---

[*] Being the concluding chapter of "Die Metamorphose der *Corethra plumicornis*, ein weiterer Beitrag zur Entwicklungsgeschichte der Insecten. Von Dr. August Weissmann. Mit 5 Kupfertafeln. Leipzig, 1866. 8vo, pp. 83.

companying the process, which cannot be brought under this head. The nature of the moulting process I see in this, that the layer of cells, which we regard as the hypodermis, and which appears as a skin split apart from the chitinous skin, after certain changes of form, develops a new chitinous skin, and that this takes place without any solution of continuity of the same. The change of form may arise merely through simple growth, accompanied by a more or less considerable remodelling; or it may be due to the formation of new, or to the disappearance of parts already present. The latter occurs through shrinkage, the former to a growing out of the hypodermis. It is the hypodermis which generally imparts to the insect its form, from which the formation of the appendages of the segments proceeds, the typical as well as the accessory.

The mere remodelling of the parts of the body already present we saw fully illustrated in the Corethra larva; thus the head gradually takes on a different form, the mandibles, in the young larva beset with long, slender bristles, afterward become thick, massive, raptorial jaws, with sharp teeth, etc. But most instructive are these relations in the antennæ, where indeed a less change of form, rather than a considerable increase in size may be noticed at each moult. This is accompanied, as we have seen, by a complete pushing inwards of the hypodermis, whereby is afforded in the only possible way an important space for the increase in size. After the splitting off of the old chitinous skin the stretched hypodermis-layer again turns back throughout its length and breadth. No more direct proof can be given for the correctness of the view which regards the appendages of the segments of Arthropods as protrusions of the skin.

This occurrence is only important as being a preliminary stage for the rise of the antennæ of the imago; still this arises through a simple, though still deep-reaching remodelling of the larval antennæ, and thus stands in relation with the other typical cephalic appendages. No enlargement of the parts takes place, indeed the hypodermis is simply loosened and models itself anew, for the most part during a perceptible decrease in size, into the antennæ of the imago; so for example the mandibles. But should, on the contrary, an enlargement take place, as in the under lip, then this arises through a pushing up of the hypodermis from the bottom of a falling-in of the body wall, and here the difference in size and form between the new and old organs is so considerable, that we can rightly indeed regard it as a new formation; the passage to the real new formation is here indicated, and we finally see also the appendages of the thorax, which in the larva are completely wanting, certainly developing in the same manner; the simple growth of the antennæ at each moulting of the larva, the formation of the fly's beak out of the under lip of the larva, and the outgrowth of wings and limbs at places in the hypodermis previously wanting them, are also only modifications of one and the same occurrence; the protrusion of the hypodermis.

So far it certainly appears legitimate to regard the formation of Corethra as a moulting process. The entire hypodermal skin it is which remodels itself, in part shortening, in part elongating and drawn out, but which never loses its continuity.

But this does happen in the Muscidæ. The hypodermis of the anterior larval segments must die, in order that the imaginal disks lying within the body cavity on the upper surface, and a new thorax and head may be composed; evidently a phenomenon which exceeds the idea of a moulting. It is a mistake to exceed known facts. It were a greater error to conclude from the fact that the imaginal disks of the Muscidæ are already formed in the embryo, that the body of the imago was already formed, as in Corethra, in which the wings and limbs begin to grow after the last moulting. The imaginal disks of Musca are not simply rudiments of the appendages of the segments, but really *the segment itself;* but in Corethra the germs of the segments of the imago are already present in the egg, not alone in the form of isolated disks, but as the complete segments of the larva, which afterwards give rise to the appendages, in order to build up the segments of the body of the adult insect. The body of the imago is also on the contrary more perfectly formed in the larva of Corethra.

It is by no means surprising that the appendages of the segments of Corethra begin to develop after the last moult of the larva. Should they arise earlier, then they would already appear during the life of the larva as external parts, the chitinous skin which in the process of moulting would separate anew would press to the half-formed appendages, and the larva would thus be no more a larva, the metamorphosis no more complete, but an incomplete one. A development of the appendages beginning *before* the last moulting would, in a metabolic insect with the mode of development of Corethra, be only conceivable if the same previously originated not as a direct protrusion, but as an invagination, also forming no projection on the upper surface of the hypodermis, as in fact seems to be the case in the wings of Lepidoptera.

But we will take a nearer glance at the mode in which the formation of the appendages and especially those of the thorax takes place. Many differences between Musca and Corethra appear, and also many resemblances, and indeed in points of great importance, so that we must say *that the formation of the thoracic appendages goes on in the two insects in essentially the same way, and indeed the process of formation may be considered as simply local protrusions of a broad, flat, basal membrane.* This basal membrane is in both cases the hypodermis of the thorax, which in Corethra at the time of formation of the appendages at once arises as a whole, while in Musca it exists only in a rudimentary way in the form of many pieces separated from one another. Ideally in fact the thorax of Corethra consists of twelve such pieces, each one of which is destined to grow out as an appendage. Only an apparent similarity lies in the relation which exists in the two Diptera between the nerves and the newly forming appendages. In Corethra all the appendages of the thorax, with the exception of the gills around the end of the body are provided with sensible (*sensibeln*) nerves; for then with their increasing growth the nerve-stalk will be surrounded. From the neurilemma of these nerves arises the formation of the tissues filling the cavity of the appendages; they form a store of cells (*zellzucherungen*) which are transformed into the tracheæ, muscles, sinews and nerves of the appendages. Only in the origin of the gills, the place of the nerve is supplied by a trachea, which in those organs wanting nerves and muscles certainly play the same part as the nerve.

The imaginal disks of the Muscidæ also stand in connection with the nerves, but the significance of this fact in regard to the development of the appendages is still quite another thing. This is due to the fact that not *all* the disks are attached to nerve-filaments, *as indeed are not all those from which originate similar appendages.* The imaginal disks of the two anterior limbs are attached to nerves; the hinder spring up from the tracheal stems without any connection with nerves. The conclusion is inevitable that the nerve-stems are here nothing else than points of attachment for the new formations. Certainly it is evident that the nerve passes through the new formation in order to reach the organ lying next to the skin (ganglion or muscle); still this is accomplished in quite a different way from the Tipulidæ, where the cavity of the appendages is traversed longitudinally by a nerve (at least in the legs), while in Musca the appendage is in fact wholly free from nerves, at all events with none of its primitive fibres present, and at best may be traversed by such as are formed anew during the outgrowth of the appendages. At all events the new formation of the tissues filling the cavity do not proceed from the neurilemma, but from the nuclei arising from the destruction of the fat body.

But still in the manner and mode, in which the growing limb pushes out, there is no inconsiderable difference.

In Corethra there is at first a completely unjointed cylindrical skin which lies wound up in a spiral on the piece of the thorax belonging to it; as soon as the new formation has evidently grown in length, when the differentiation of the cell-masses of the cavity into tissues has advanced, the first traces of joints appear.

Quite otherwise in Musca, where the segmentation begins at an early period and is complete along the whole length of the projecting appendage. Even before the growth outwards of the limb ever projects up prominently above the level of the basal membrane, the end of the limb (the fifth tarsal joint), is separated from the basal membrane; then with the elongation of the tarsal spines, the four other tarsal joints become interpolated, while the tibia and fibula still form an unjointed portion, whose complete division into the joints of the fly's limbs occurs after the formation of the thorax. During the whole development within the disk the limb still remains as a short projection which, without turning, stands straight up over its thoracic piece. As soon as the new thorax is formed, it begins to grow moderately, and considerably later, in the second half of the pupal sleep, the muscles and other tissues arise in the cavity of the appendages, and finally the limb assumes its external, definite form. From the last mentioned facts, it clearly appears that with the existence of imaginal disks, which the muscid larva brings with it out of the egg, no greater preparation in fact is made for building up the body of the imago; that here a much more marked transformation must be undergone. When Corethra transforms into a pupa, the muscles of the wings and limbs are already formed, while in Musca there is not yet the first trace to be seen of either; the mouth parts undergo in Corethra only a final modelling, while in Musca the head does not yet appear as a whole, and nothing of the beak is yet formed.

But if in relation to the external form and formation of the tissues in the interior the Corethra larva stands nearer its imago, so not less as regards the systems of internal organs. Here also we find a complete continuity between larva and pupa; no new organs arise in place of the old, but the old either remains the same, or are wholly intact, or with only slight changes, as are required for the changed mode of life of the animal; thus the dorsal vessel passes wholly unchanged over into the fly, and except the slight shortening of the œsophageal ring, the nervous system also. Other organs are completed through increase in size in some, through concentration and disappearance in other places, as for example in the digestive canal, and the sexual organs which had long previous been completely formed. Only parts which are single become entirely superfluous and disappear and never arrive at a complete, new structure, independent of the systems of organs already present.

It is wholly otherwise in Musca, where all the systems of organs of the larva disappear, and are formed anew from new building materials, whether they return to molecules, which mingle with the blood, as the hypodermis of the anterior larval segments, as all the larval muscles, many of the tracheæ, the anterior part of the digestive canal; or whether they pass through that interesting process which I have termed *histolysis*, and whose nature consists in a destruction of the histological elements, without giving up the general form of the organ, and in a succeeding new formation from the ruins of the tissues.

But most remarkable and pregnant is the difference in the processes of growth within the body of the pupa, since in Corethra the fat bodies play throughout a very subordinate and scarcely perceptible part, while in the Muscidæ a building up of the inner organs without the intervention of this important part of the body were not possible. There is need only for the colossal mass of the fat body in the muscid larva; and seeing the thick whitish pap-like substance, with the product due to its destruction filling the body-cavity of the pupa, we can estimate the true significance of the fat body in the development of the Muscidæ. And it would appear that the fat body in these insects is not only a depot of nutritive material, but that out of the products arising from its destruction, entirely new histological form-elements arise: the masses of nuclei which fill the body-cavity of the pupa with a compact mass, whose brood of cells, multiplying through endogenesis, arrange themselves into strings and thus form the primitive germs of the tracheæ and in fact the muscles.

Indeed it is difficult to tell out of what material the muscles of the wings of the Muscidæ should arise, if not out of the descendants of the masses of nuclei. But in Corethra we find the corresponding muscles already indicated in the embryo in the form of fine filaments; but how could this be the case in the Muscidæ, where the points of attachment of such filaments, the hypodermis of the thorax, are not yet present in the larva? And the same conclusion follows in regard to the tracheal system of the imago, which in Corethra is indicated beforehand, the entire division of the body of the imago answering to the corresponding segments of the larva—which in Musca can only arise when these regions are formed, *i. e.*, in the course of the pupal life.

Thus in every relation a much less morphological connection exists between larva and imago in the Muscids, than in the Tipulids, and in this fact is to be sought the reason for the relation of the duration of larval life to the long pupal stage.*

In Sarcophaga it requires eighteen days from the pupation to the exclusion of the fly, in Corethra only three. However, on the other hand the life of the larva of Sarcophaga lasts only eight days, in Corethra three or more weeks, and this difference cannot alone be referred to the wholly opposite mode of nourishment of the two larvæ, which makes it possible in the Musca larva to suffer a great mass of food to pass in a few days through its intestine, while the Corethra living by robbery only slowly procures food. The evidence lies in the very long interval, which separates the last moulting of the larva from the pupation in Corethra. It is surely not unimportant or adventitious, but will be met with in cases where the origination and completion of the appendages of the imago must take place within this period.

The pupa of Corethra manifestly differs in morphological as well as physiological relations from the pupa of the Muscidæ; it does not *become* the imago, but it *is* nothing else from the start, and undergoes only a slight completion, in order to slip out from the pupa-skin as a winged and sexually mature insect. A pupa-sleep in the true sense it thus completely lacks, all functions of animal life in the pupa go on uninterruptedly, only the act of taking food ceases. All the occurrences which fill out the interval of latent life in Musca, during which the blood no more circulates, every sensation and movement, as well as the taking of food—every act which may go under the head of "formation of the pupa" fall in Corethra into the larval period, and the pupal stage is to be compared with the two last days of the Muscid pupa; when still in this respect the almost fully formed insect stands near its final perfection, since it, if artificially freed from its tun-shaped case, is more or less movable and lively.

---

* Evidently it is only the relative, not the absolute duration of the pupa-stage, which is here considered. This may vary in one and the same species between wide limits; for example the pupa-stage of Corethra lasts only three days in midsummer; in March the same lasts eight days. But also the corresponding life of the larva is longer in such March pupæ, the larvæ having wintered over from the preceding autumn. In the Muscidæ on the contrary, the pupa winters over.

Finally, we may distinguish two diametrically opposed forms of insect metamorphosis; the one represented by Corethra stands nearest to development without metamorphosis; the other represented by Musca is farthest removed from the ametabolic development and is the most extreme form of metamorphosis. Expressed in a very general way, the difference between the two consists in this, that at one time a *continuous*, at another a *discontinuous development* occurs, in the sense, namely, that the parts of the body and organs of one stage of development originate directly from the similar parts of the foregoing stage; or if such is not the case, rather the parts of the body and internal organs of the later stages of development are substantially new formations.

We may briefly characterize the two modes somewhat thus:—

Type Corethra. *The larval segments are converted directly into the corresponding divisions of the imago; the appendages of the head into the corresponding ones of the head of the imago; those of the thorax arise after the last moult of the larva, as outgrowths of the hypodermis around a nerve or trachea, from the cellular envelope of which the formation of tissue in the interior of the appendages issues. The larval muscles of the abdominal segments are transferred unchanged, into the imago; the thoracic muscles peculiar to the imago, as also some additional abdominal muscles, are developed in the last larval period from indifferent cellular filaments which are indicated even in the egg. The genital glands date back to the embryo, and are gradually developed; all the other systems of organs* *pass with little or no alteration into the imago. Fatty body none or inconsiderable. Pupa state short and active.*

Type Musca. *Thorax and head of the imago arising independently from the corresponding divisions of the hypodermis of the larva; only the abdomen directly through the transformation of the eight hinder larval segments. Thorax and head with their appendages develop from imaginal disks, which are of embryonal origin and are attached within the cavity of the body to nerves or tracheæ. Immediately after the formation of a tun-shaped pupa case from the chitinous skeleton of the larva, the imaginal disks grow together into the thorax and head. Destruction of all the systems of larval organs, either total or through histolysis. New formation of the same by means of the masses of nuclei arising out of the destruction of the fatty body. Genital glands indicated in the embryo have a continuous further development. Pupa state lasting for a long time and with a latent life.*

The two types are most sharply distinguished from each other by the presence or absence of true imaginal disks, and I might for this reason suggest dividing those insects having a metamorphosis into *Insecta discota* and *adiscota*.*

A subsequent memoir remains to be prepared, in which an effective division is to be made showing what families belong to one and what to the other group. It may be here previously observed, that the two groups do not stand completely opposed, without transitions, but that there are intermediate forms; indeed whole families, perhaps whole orders of insects may on account of the want of imaginal disks be regarded as *Insecta adiscota*, while their development in other respects may closely join them to the *discota*.

---

* The italics in this translation are the author's.

ON THE COTTON WORM OF THE SOUTHERN STATES (ALETIA ARGILLACEA Hubner).

BY AUG. R. GROTE.

THE earliest* scientific name for the cotton worm is given by Jacob Hübner in the second hundred of his "Supplement to the Collection of Exotic Lepidoptera," dated 1822. The moth is there figured in two positions under the numbers 399 and 400, and described under the name *Aletia argillacea* on page 32. Although the insect has subsequently received different names, this name of Hübner's is the one it should in future bear. For the name "*Anomis xylina*," now in scientific use, I am responsible. In the year 1864, in the Proceedings of the Entomological Society of Philadelphia, I referred the *Noctua xylina* of Thomas Say to Hübner's genus Anomis, as defined by M. Guenée, and regarded as synonymous the *Anomis bipunctina* of the latter author.

With the true type of the genus Anomis, the *Anomis erosa* of Hübner, I have since then become familiar, and I find that it differs structurally and generically from the cotton worm moth, which latter must accordingly remain under the combined title originally proposed for it by Hübner.

The different stages of Aletia, as it is found throughout the cotton belt of the Southern States, have been faithfully portrayed by Professor Townend Glover, of the Agricultural Department in Washington. On the Professor's plates numerous other insect depredators on the cotton plant are excellently portrayed, and this work (I believe as yet unpublished) ought certainly to be issued by the Legislatures of the different states interested in cotton culture, or indeed by the General Government, and publicly distributed, so that a knowledge of the economy of these parasites be diffused. For his manuscript work, Professor Glover has indeed received a medal from the late Emperor of the French (a nation fortunately profuse in acknowledgment) but, if I am correctly informed, no more substantial reward has as yet crowned Professor Glover's praiseworthy efforts for the advancement of knowledge and the consequent amelioration of his race.

---

* I am indebted to Dr. Hagen for the bibliography of the *Noctua gossypii* of Fabricius. I believe this to be a distinct species from the *Aletia* and probably belonging to a different family.

In the Second Report on the Insects of Missouri, Professor C. V. Riley notices the cotton worm, and illustrates the moth by a woodcut, in which the insect is represented head downward in a state of rest. The moth is drawn in this position on the authority of a gentleman in Texas, and the subject is treated throughout, and indeed necessarily, by Professor Riley, at second-hand. In Professor Riley's Sixth Report (published this year) the cotton worm is again discussed under similar conditions, while the position of the moth in a state of rest has now become normal. It is however claimed, in this Report, that the cotton worm "hibernates" as a moth, and the credit of this observation is given to the Second Report, while the discovery of the fact is claimed to have been made by what Professor Riley calls the process of "analogy."

It is the object of the present paper to throw, happily, some light on the biography of the cotton worm as it occurs in the Southern States, and in so doing I think it will become apparent that Professor C. V. Riley has regarded the same subject from an erroneous standpoint, having considered the cotton worm as belonging to our fauna, and accordingly misunderstood its economy as displayed with us and far from its natural abode. And here, while I am obliged to differ on a scientific question with Prof. Riley, I bear willing testimony to the great good achieved by the publication of the Missouri Reports.

The *Aletia argillacea*, or cotton worm, is an insect belonging to the Noctuæ, a group of nocturnal moths. It is one of a number of intertropical or southern forms, somewhat nearly allied to our more thickly scaled and northern genus Plusia. The caterpillar is a "half-looper," to use a common term, and the chrysalis is held within an exceedingly loose web on the plant, the few threads usually binding over the edge of the leaf and of themselves furnishing no adequate protection to the pupa. [I here exhibit to the Association specimens of the larva, pupa and moth of Aletia]. Technical descriptions of the different stages are already extant and so may be passed over here. The more immediate question for our solution is the consecutive history of the insect, so that we may be prepared to offer suggestions to the agriculturists for its destruction.

The region over which, during five seasons, I have observed the cotton worm, embraces the central portion of the cotton belt in the states of Georgia and Alabama, and in particular the counties of Marengo and Greene, lying along the Tombigbee and Black Warrior rivers. There cotton is planted in March and April, blooms in June and July, and perishes in November or with the frost. The earliest period at which I have noticed the young worm was the last week in June, and its usual appearance was in July, sometimes as late as the latter part of the month. Its date of appearance was irregular, and never accurately coincided in any two seasons. Sometimes it seemed as though we were "*not going to have any worm at all this year*," a remark suggested by hope and the tardiness of its advent. My observations have been mainly directed to the question of the origination of the first brood and have led me to record the following results. I have observed that the appearance of the worm in the fields was always heralded by flights of the moth, which came to light in houses at least a week before the worm was noticed on the plants. I have observed that the distribution of the first brood was irregular; the worms occurring here and there over miles of country, while infesting some plantations, skipping unaccountably others which the second brood, however, seldom failed to reach. I have noted that the worm was always heard of to the southward at first, and never to the northward, of any given locality in the cotton belt. Finally, after diligent search, no traces of the insect in any stage could be found by me during the months *preceding* the appearance of the first brood heralded by the moth, and *after* the cotton was above the ground. The broods themselves were consecutive and without interruption so long as the conditions were favorable. The last brood, in years where the worm was numerous, eat up every portion of the plant that was at all soft, flowers, the persistent calyx, the very young boll, the terminal shoots. The last brood of worms changed into chrysalides in myriads on the leafless stems, clinging by their few threads as best they might, and disclosed the moth in the face of the frost, many of the chrysalides perishing. Afterwards, on sunny winter days, I have noticed the live moth about gin houses and fodder stacks, or the negro quarters. Was this a true "hibernation" or merely an accidental survival? The locality and the condition seem to me alike artificial.

Now Hübner describes the moth of the cotton worm at first, as from Bahia. Sufficient testimony to the identity of our insect with one destructive to the West Indian, Mexican and Brazilian perennial cotton, is at hand and the fact is established. In a classificatory point of view, the affinities of the cotton worm are with southern rather than northern forms of its family, as I have already pointed out. The conclusion to which I have come with regard to the cotton worm is, *that it dies out every year* (*with its food plant*) *that it occurs in the cotton belt of the Southern States, and that its next appearance is the result of immigration.* Testimony is at hand to show that for many years after the cultivation of the cotton plant was introduced into the Southern States, the cotton worm never appeared. The date at which it first appeared in Central Alabama has been differently stated to me, but it evidently but little preceded the late war. That the moth is capable of sustaining long and extended flight is readily proven. Professor Packard observed the moth off the coast of the Eastern States, as also Mr. Burgess. I have observed the moth in October in Buffalo, N. Y., as also Dr. Harvey. According to Mr. Riley the moth has been observed in Chicago, I presume in the Fall. It seems that the moth follows the coast-line northward as also the water courses that empty into the Gulf of Mexico. It is noteworthy here that the water-shed of the Ohio and Mississippi, extends to within fifty miles of Buffalo. As an example of the prolonged flight of moths, I will state, that I have observed in the Gulf Stream, off the Carolinas and out of sight of land, in the month of August, large numbers of a moth, the *Agrotis annexa* of Treitschke.

Again I have been struck by the absence of parasitic checks to the cotton worm in the south. I could never discover any, although such may exist. Spreading as I believe it to do, as a moth, the absence of peculiar parasites to the worm may be reasonably accounted for. I have already and elsewhere pointed out, that in order to make the first brood of the cotton worm the progeny of the so-called "hibernating" individuals (as Professor Riley would suppose), a period of several months has to be accounted for, since these "hibernating" moths could not wait till midsummer to deposit their eggs; and while the cotton is young, and even before it is up, insect life is active, and the weather is warm and other vegetation fully out in the region of the South where I have lived. There is also no reason to believe that the cotton worm ever breeds in the North, and this, notwithstanding Professor Riley's suggestions to the contrary, in the Sixth Report before mentioned. The worm never has been noticed on any other plant than the cotton, and in the south perishes by thousands rather than eat any other. The habit of wandering in masses when food fails is a proof of this, as while the worm is supplied with cotton leaf it never quits the plant, transforming to the chrysalis on the stalk which has furnished it nutriment. The wandering habit is not normal but accidental, and the worm is not "gregarious" like the "tent caterpillar." Its "hibernation" with us must also be regarded as accidental, or at least as barren of results. For when spring comes the *Aletia argillacea* has vanished, and is not found with the hibernating species of Lepidoptera, renewedly active. And if it *were* found in February and March, it would find no cotton plants upon which to deposit its eggs. If oviposition ever takes place in these months in the cotton belt, the young cotton, free from worms, disproves its efficacy.

It is possible that in the southern portions of Texas, or the Floridian peninsula, the Aletia may sustain itself during the entire year; I have no means of information on this point. My observations are made on its occurrence over the central and principal portions of the cotton belt and into which I believe it to be imported *de novo* every season that it there occurs and from more southern regions.

I conclude, therefore, that while the cotton plant is not indigenous to the Southern States (where it becomes an annual), the cotton worm moth may be considered not a denizen, but a visitant, brought by various causes to breed in a strange region, and that it naturally dies out with us in the cotton belt, unable to suit itself *as yet* to the altered economy of its food plant and to contend with the changes of our seasons.

When this fact is comprehended, it will simplify the process of artificial extermination by limiting the period during which we can successfully attack the cotton worm, and by doing away with a certain class of proposed remedies.

From the foregoing it will be evident that 1. The artificial agent employed to destroy the cotton worm must be employed against the first brood as it appears in any given locality during the progression of the moth northward; and 2. That, in order to be effectual, a concerted action in the application of the remedial agent in any given locality will be found necessary.

I also recommend the introduction of the English sparrow into the Southern States, and additional legal protection to insectivorous birds. Since the war there has been too much ignorant use of the gun on the part of the negroes. *All* the birds should be protected as much as possible, for many species not usually considered insectivorous are yet found, during certain seasons of the year, to live on insects.

I offer the following as the synonymy of the cotton worm in scientific literature:

Aletia argillacea Hübner, Zutr. 3d Hund., S. 32, figs. 399–400 (1822).

Noctua xylina Say,* Sec. Ed. Vol. 1, p. 370 (1859).

Anomis grandipuncta Guenée, Noct., Vol. 2, p. 400 (1852).

Anomis bipunctina Guenée, Noct., Vol. 2, p. 401; id. Vol. 3, p. 397 (1852).

Anomis xylina Grote, Proc. Ent. Soc. Phil., Vol. 3, p. 541 (1864).

Anomis xylina Riley, 2nd Mo. Rep. p. 40, fig. 13 (1870).

Anomis xylina Grote, Rural Carolinian, 3, p. 88 (1871).

Anomis xylina Riley, 6th Mo. Rep. p. 17 (1874).

Aletia argillacea Grote, List of the Noctuidæ of N. America, p. 24.

---

* In a letter to C. W. Capers, dated Nov. 1st, 1827. I do not know whether this letter is elsewhere published, but this question will not affect the synonymy here proposed

LIFE HISTORIES OF THE PROTOZOA.

BY A. S. PACKARD, JR.

THE design of the present series of papers is to give the results of studies by different authors on the development of the typical forms of animals, beginning with the lowest and ending with man.

I. THE MONERA.

Structure and Habits. Hæckel, in 1868, applied to this group of organisms, which are doubtfully referred to the animal kingdom, the term *Monera* (from μονήρης, simple) in allusion to the extreme simplicity of their structure. "Their whole body," he remarks, "in a fully developed and freely moving condition, consists of an entirely homogeneous and structureless substance, a living particle of albumen, capable of nourishment and reproduction." They differ from the Amœbæ, hitherto supposed to be as simple as any organism, in the want of a nucleus and of contractile vesicles. Moreover, they (as in Protamœba) differ from the Rhizopodous Amœba in being entirely homogeneous in structure, there being, as Hæckel observes, "no apparent difference between a more tenacious outer and a softer inner sarcode mass," as is "perceptible in most, perhaps in all, true Amœbæ."

The motions of these Moners are effected by contraction of the homogeneous substance of the body, and by the irregular protrusion of portions of the body, forming either simple processes (pseudopodia) or a net-work of gelatinous threads. The food is taken in after the manner of the Amœba, the diatom, desmid or some protozoan being surrounded by the pseudopodia and gradually enfolded by the extremely extensible body mass. Hæckel says that reproduction is effected solely in a non-sexual manner. "Often, but not always, the freely moving condition alternates with a state of rest, during which the body surrounds itself with an excreted structureless covering," becoming in fact encysted.

The Monera are divided into two groups:

1. *Gymnomonera*, comprising the genera *Bathybius*, *Protobathybius*, *Protamœba*, *Protogenes* and *Myxodictyum*, which do not become encysted and consequently protected by a case.

2. *Lepomonera*, which become encysted and protected by a case, as in the genera *Protomonas*, *Protomyxa*, *Vampyrella* and *Myxastrum*.

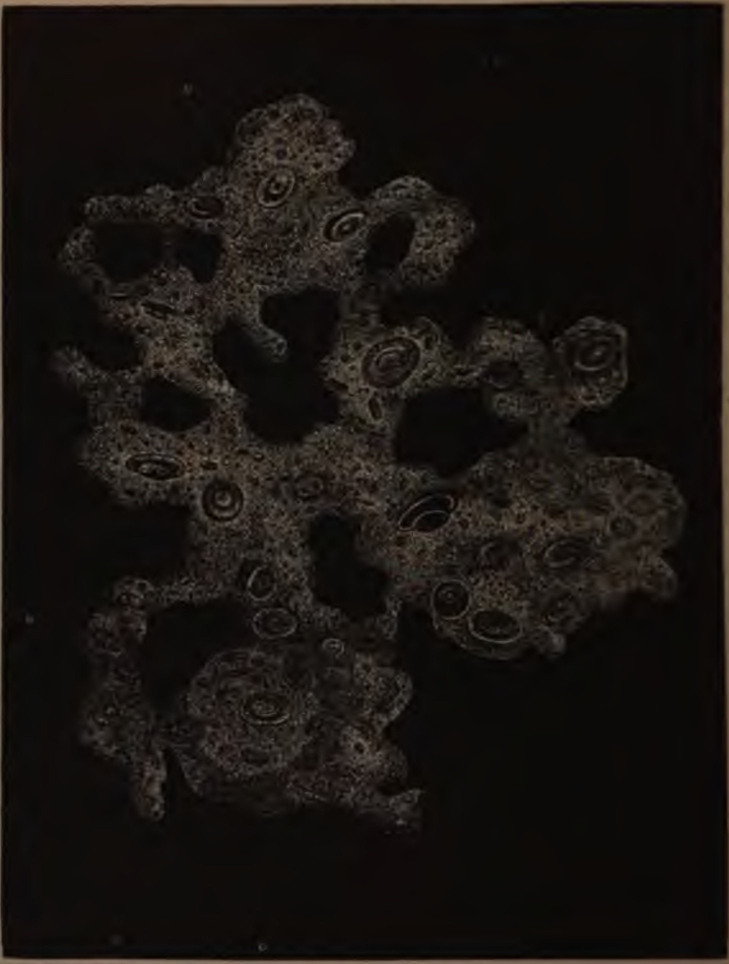
The simplest form of all is Protamœba, which is a simple mass of protoplasm without vacuoles (little cavities), which protrudes simple processes (pseudopodia) not ramifying or forming a network. Protogenes differs in protruding ramifying and anastomosing gelatinous threads, while Myxodictyum, the most complicated form, is made up of several simple Actinophrys-like bodies, whose pseudopodia branch out and interlace, forming a net.

The simplest form of life known to us is Bathybius, a mass of albuminous jelly. If the theory of spontaneous generation should ever prove true we could imagine that the first living form would be like this organism, a mass of jelly, utterly structureless, and yet capable of motion (irritability), of taking food and digesting it, and of reproducing its species, and thus having an individuality.

Bathybius is consequently the most interesting organism (should it be proved to be such,) known except man. It cannot be said to be distinctively either animal or plant, though it has been studied chiefly by zoologists, and intergrades with the higher Moners, which seem to pass by the sum of their characters into the Amœbæ and higher Rhizopods rather than into the Protophytes. But in the Moners we find a group of uncertain forms from which the plant and animal kingdoms diverge, and from which, consequently, they may have taken their origin. The Moners stand in the same relation to the whole world of organized beings that the egg does to the animal kingdom. All animals exist first in the form of nucleated cells, while the primitive form of plants and animals collectively, is a simple non-nucleated mass of protoplasm like Bathybius, and for these forms, neither distinctively plant nor animal, Hæckel's term Protista is a convenient one for *provisional* use.

Bathybius was first discovered by Prof. Wyville Thompson in 1869 in dredging at a depth of 2435 fathoms at the mouth of the Bay of Biscay. He describes it as a "soft, gelatinous, organic matter, enough to give a slight viscosity to the mud of the surface layer." Thompson also adds that if a "little of the mud in which this viscid condition is most marked be placed in a drop of sea water under the microscope, we can usually see, after a time, an irregular net-work of matter resembling white of eggs, distinguishable by its maintaining its outline and not mixing with the water. This net-work may gradually alter in form, and entangled granules and foreign bodies change their relative positions." To

Fig. 126.



Bathybius.

this low Moner Huxley has given the name of *Bathybius Hœckelii* (Fig. 126, with coccoliths embedded in the protoplasm, from Thompson's "Depths of the Sea"). This Moner, adds Thompson, "whether it be continuous in one vast sheet, or broken up into circumscribed individual particles, appears to extend over a large part of the bed of the ocean." It should be stated that Thompson and others do not believe that Bathybius is really an organic being. Bathybius has been discovered at a depth of from fifty fathoms downward in the Adriatic Sea, by Oscar Schmidt. The Bathybius mud was detected by its yellowish-gray color and its characteristic greasy nature.

Under the name of Protobathybius Dr. Bessels mentions a Moner allied to Bathybius, which is a non-nucleated mass of protoplasm. It was discovered at a depth of ninety fathoms, mud, in Polaris Bay, Northern Greenland.

The *Protogenes primordialis* of Hæckel is a simple, shapeless mass of protoplasm, without vacuoles, but with over 1000 very fine pseudopodia, with numerous ramifications and anastomoses. The largest specimens are ·04 inch in diameter. It is a marine form, found at Nice. It reproduces by fission.

Myxodictyum is made up of several individuals, each one of which is like Protogenes, but with fewer pseudopods. *M. sociale* Hæckel, in the single specimen observed, formed a mass nearly an inch and a half in diameter, and was discovered in the Straits of Gibraltar.

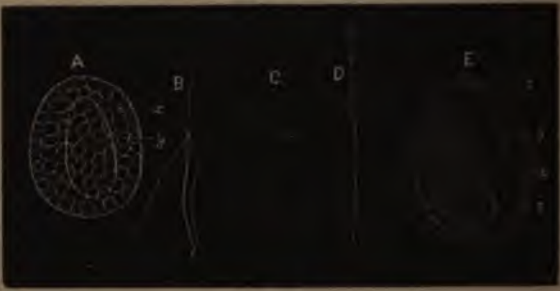
Protomonas amyli (Ckski.) is a fresh-water, monad-like form, found by Cienkowski in Germany and Russia, and is from ·08 to ·20 inch in diameter. *Protomyxa aurantiaca* Hæckel has vacuoles in its simple, shapeless, orange-red body, and in the encysted condition is a globular jelly-like mass over half an inch in diameter. It occurred on empty shells of *Spirula Peronii*, floating about on the open sea, and driven in on the coast of one of the Canary Islands. *Vampyrella*, as its name implies, is a jelly-like mass, which according to Cienkowski bores into the cells of confervæ and other fresh-water algæ, and sucks out their contents. Another species, *V. vorax*, engulfs diatoms, desmids and infusoria, drawing them into the interior of its body.

The highest form among the Moners is *Myxastrum radians* of Hæckel, which forms a radiating ball of jelly of tough consistence from ·12 to ·20 inch in diameter. It has very tough, stiff pseudopods. In the encysted condition it is nearly half an inch in diameter, and occurred on the beach of one of the Canary Islands.

Development. In Protamœba and Protogenes, Hæckel tells us we find the simplest possible mode of reproduction. They multiply by merely dividing into two portions, each part becoming an individual.

The distinguished Russian microscopist Cienkowski has given an account of the mode of development of *Protomonas amyli*, which corresponds to that of the lowest algæ, such as Protococcus (see Clark's Mind in Nature, p. 136, Figs. 73–79); both reproduce by spores; those of the animal Protomonas may be called "zoospores." Fig. 127 (copied from Cienkowski) represents at A this moner during the formation of the zoospores; B, a zoospore hatched out; C, D (A — D × 350 diameters), the Amœba-like form it afterwards assumes. From these stages Cienkowski traced it to the encysted, or resting stage, E; (*y*, food; *s*, a projection inwards of the cell-wall; *x*, moner-cyst × 450). This form lives in putrefying Nitellæ. It should be observed that the cyst of this Protomonas, as in the true Monads studied by Cienkowski, is composed of cellulose, while the granular contents become colored with chlorophyll. In these respects they are *plants*, but it should be remembered that cellulose is said to occur in the mantle of the Tunicates and various parts of Articulates and Vertebrates, while chlorophyll occurs in the Infusoria and Hydra.

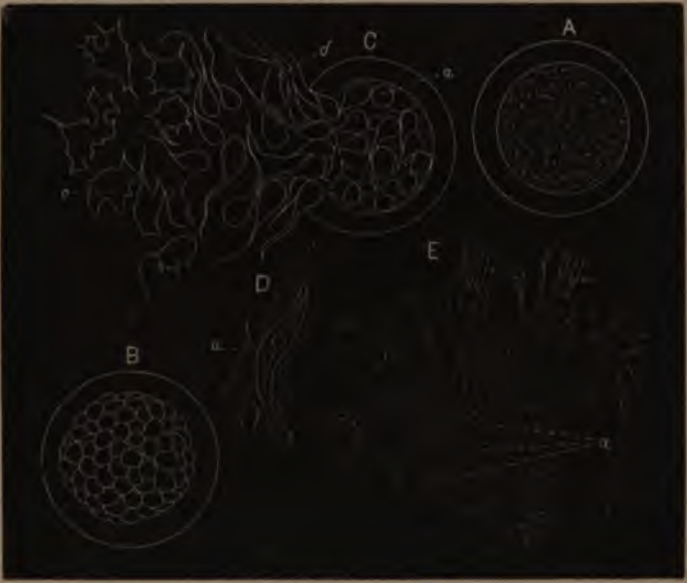
Fig. 127.



Development of Protomonas.

The course of development of Protomyxa has been observed by Hæckel. The orange-red contents of the ball or cyst (Fig. 128, A) of this moner, divided, after it had retracted itself from the hyaline capsular wall, into several hundred small, round, thoroughly structureless, naked balls (Fig. 128, B). This process Hæckel regards rather as a "germ formation," than a process of division or gemmation. These small globular masses of protoplasm (a) are each drawn out into a long tail (b), and issue from the cyst as "swarm-spores" (zoospores, Fig. 128, C *a*, *b*, *c*). These zoospores then assume an amœba-form. These unite by twos or threes, or more, and form a new individual as at D, where two amœba-like germs unite themselves by their anastomosing pseudopods and draw themselves over a Diatom (*a*), meet in the middle, and unite into one individual moner. Fig. 128, E, represents a fully grown *P. aurantiaca* after having had a liberal diet of shelled Infusoria (E, *a*). From the central sarcode body the very strong, branching, tree-like pseudopods radiate, their outer anastomoses forming numerous crescent-shaped meshes. The vacuoles extend into the larger pseudopods; they first appear in the Amœba stage after they begin to take food.

Fig. 128.



Development of Protomyxa.

This adult, Amœba-like form becomes encysted in the manner thus described by Hæckel. "To complete the natural history of the Protomyxa, it still remained only to observe the encysting of the adult form, the transition from the free moving plasmodia to the stationary red balls which had attached themselves to the Spirula shells near the latter. I succeeded in establishing this also. Two of the largest of the best fed plasmodia, which contained very numerous vacuoli, and which had formed a very extended sarcode net, with many branches and anastomoses, after some time began to slacken their extremely rapid currents, and to simplify their pseudopods. The silicious shells of the many diatoms which had been absorbed were rejected, and the branches and twigs of the pseudopods were successively retracted. At last they drew back the main stems, which had everywhere become simple, into the central plasma-body, and the entirely homogeneous sarcode body took the form of an irregular lump, and finally rounded itself into a regular ball.

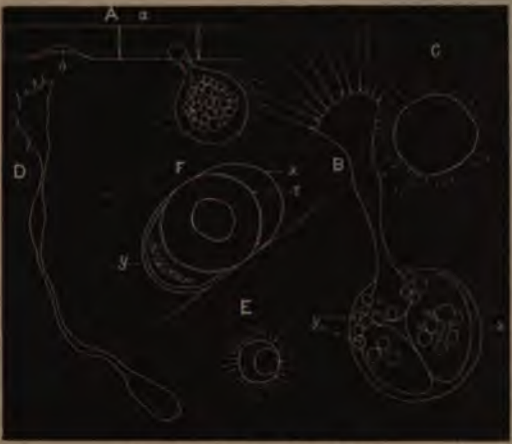
"Now commenced the separation of the covering of the cyst, in which the sharply defined single outline of the orange-red plasma-balls passed into a perceptible, though certainly fine, double outline. A second, and then a third, concentric boundary line soon followed this, and then the proper concentric hyaline cyst-covering appeared somewhat quickly (in the course of a day): its layers corresponded with the above stated breaks of the separated gelatinous skin. At first a quantity of vacuoli were still perceptible in the plasma during the encysting process, which appeared and disappeared here and there, but visibly decreased in numbers; and after the complete development of the cyst covering, no vacuoli could be any longer perceived in the orange-red plasma, now interspersed with numerous granules. The encysted plasma-ball was now no longer to be distinguished from those red balls whose transition to the mass of sporules I have above described. Thus was the cycle of the generation of the Protomyxa completed, and the course of its simple and remarkable life history established."

The phases may be thus summed up: —

1. The free swimming flagellate state (sporule or zoospore).
2. The creeping Amœba state.
3. The reticulated Rhizopod state.
4. The encysted state.

Somewhat similar is the development of *Vampyrella spirogyræ*, which penetrates into the cells of the fresh-water plant Spirogyra, and absorbs its protoplasm. Fig. 129, A, represents the adult, with its radiating pseudopods, and a large one in the act of boring into the walls of the plant. It then withdraws its pseudopodia, and assumes what Cienkowski calls the cell-state. During this period it is surrounded by a delicate membrane. The granular contents divide into three portions, each of which becomes an Amœba-like being (Fig. 129, B, showing one creeping out of the cell, *x*. C, D, E, the Amœba-like stage). Finally one of these

Fig. 129.



Development of Vampyrella.

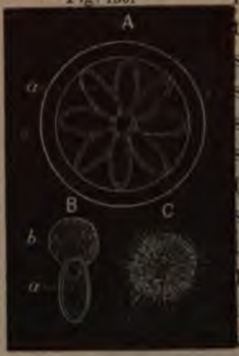
Amœba-like forms becomes encysted (Fig. 129, F, *y*, the food-granules; *t*, cell-wall of the cyst). To sum up the life-history of Vampyrella as observed by Cienkowski, we have:—

1. An Amœba-stage.
2. A cell-stage.
3. A second Amœba-stage.
4. An encysted stage.

So exactly does this mode of development parallel that of *Colpodella pugnax* described by Cienkowski, who regards it as a flagellate infusorian allied to Monas, that we doubt the naturalness of Hæckel's division of Monera. Colpodella and in fact Protomonas differ from the Monads (Flagellata) simply in having no nucleus. Whether this may not be found on further observation, or whether its absence or presence is so important as Hæckel thinks, future observation will show. We are now inclined to regard the Monera as a somewhat artificial group. It should be noticed that none of the other Moners have a "cell-state," but the Amœba-like organism becomes encysted at once after becoming fully fed.

The development of *Myxastrum radians* of Hæckel is much like that of Protomyxa, but differs in some important respects. The cyst becomes filled with numerous conical portions, whose points rest towards the centre of the ball, while their rounded bases produce a mulberry-shaped outline externally. In the next stage these cone-shaped divisions have assumed a spindle shape, and each separate spore has developed a silicious covering (Fig. 130, A, a). When the spindle-shaped spore has been set free the protoplasmic contents (b) slip out of the silicious shell (Fig. 130, B, a), and assume an Amœba form, with numerous radial pseudopods (Fig. 130, C), which in the fully formed Moner become as long as the diameter of the body.

Fig. 130.



Development of Myxastrum.

With the facts that have been presented, the question arises whether these moners are animals or vegetables. Structurally, and in their mode of development, the Monera would seem not to differ essentially from the lowest plants, such as the Myxomycetes and lowest Algæ; but physiologically, or *in what they do*, they differ, as H. J. Clark (Mind in Nature, p. 151, 156) says of Amœba, in taking in living organisms entire, digesting their protoplasm and rejecting the silicious coverings of the diatoms or infusoria they have swallowed. The plants of correspondingly low organization on the contrary absorb only the elements in an unorganized state.

LITERATURE.

Hæckel. Ueber den Sarcodekörper der Rhizopoden. (Siebold und Kölliker's Zeitschrift für naturwissenchaftliche Zoologie, xv. 1865.)

—— Monographie der Moneren. (Jenaische Zeitschrift für Medicin und Naturwissenschaft, iv. 1868. Translated in Quart. Journ. Microscopical Science, 1869.)

Cienkowski. Beiträge zur Kenntniss der Monaden. Schultze's Archiv für Microskopische Anatomie. Bd. 1. 1865.

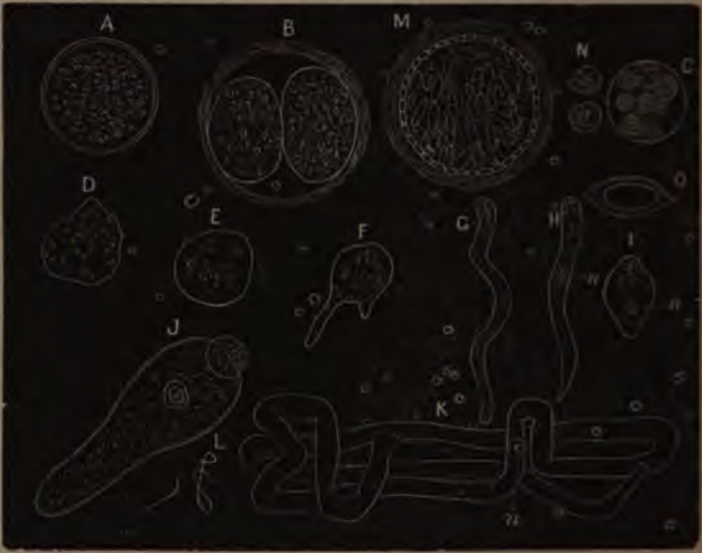
Huxley. On some Organisms living at great Depths in the North Atlantic Ocean (Bathybius. (Quart. Journ. Micr. Sc., viii. 1868.)

II. THE GREGARINIDA.

Structure and Habits. First discovered by Dufour, these parasitic protozoans, with an organ, *i. e.*, a nucleus, were considered as the lowest animals until the discovery by Hæckel of the still simpler Monera. It is now known that they pass through the Moner-state and attain a true Amœba condition, having an outer, clear, muscular, and an inner, medullary or granular, layer, which are more distinct than in the Amœbæ, and also a nucleus. In form they are more or less worm-like. They are parasitic, living in many types of animals, especially the insects and worms, and vary greatly in form. The largest species known is *Gregarina gigantea* (Fig. 131 after Van Beneden), which lives in the intestinal canal of the European lobster. It is worm-like, remarkably slender, being ·64 inch in length. It is, in fact, the largest one-celled animal known, and in size may be compared with the cells of some vegetables; in the animal kingdom it is only surpassed by the eggs of birds, which are really cells. In this organism an external, structureless, perfectly transparent membrane, with a double contour, can be very clearly distinguished. It represents the cell wall of other cells. Beneath this outer wall is a continuous layer of contractile substance, by which these animals retain their form, not changing as in the Amœba. It was first discovered in 1852, by Prof. J. Leidy. He showed that there existed under the cuticular, structureless membrane, a so-called muscular layer, which in contracting becomes longitudinally folded, so as to produce a marked striation. Van Beneden adds that in "the immense Gregarina of the lobster I have assured myself of the presence of, under the cuticle, a true system of muscular fibrillæ, comparable to those of the Infusoria." From this fact he places these animals above the Amœbæ, which move by the simple contractility of their sarcode or protoplasm, a property of all animal and vegetable protoplasm generally. He therefore opposes the opinion of Hæckel that the Gregarina is an Amœba, degraded by its parasitic life.

The internal granular matter of the Gregarina is extremely mobile, like protoplasm generally. "The whole cavity of the body is filled," says Van Beneden, "with a granular matter formed by a viscid liquid, which is perfectly transparent. This holds in suspension fine granulations of a rounded form, which are formed by a highly refractive and slightly yellow matter." In this granular matter the nucleus is suspended. The nucleus is surrounded by a membrane, and the cavity of the vesicle is filled by a homogeneous, colorless and transparent liquid. This nucleus contains an inner vesicle, or nucleolus, which has the singular feature of spontaneously appearing and disappearing in a very short space of time. "If one of these Gregarinæ of moderate size is observed, the nucleus is seen at first provided with a single nucleolus, presenting some seconds later a great number of little refracting corpuscles, of very variable dimensions, which are also nucleoli. Some of these enlarge considerably, whilst the primitive nucleolus diminishes in volume little by little, finally disappearing. The number of nucleoli varies at every instant." These novel observations are considered of great importance by Van Beneden as showing that the nucleolus of the Gregarina, and consequently the nucleoli of cells generally are sometimes, if not always, devoid of a membrane. And he draws the inference "that the nucleus of a cell is not necessarily a vesicle, and that contrary to the generally received opinion, a nucleus of a cell may be equally devoid of membrane," though we may add that he saw it in the Gregarina of the lobster. Van Beneden distinguishes three kinds of motions in the Gregarinæ. 1. They present a very slow movement of translation, in a straight line and without the possibility of distinguishing any contraction of the walls of the body which could be considered as the cause of the movement. It seems impossible to account for this kind of motion. 2. The next kind of movement consists in the lateral displacement of every part, taking place suddenly and often very violently, from a

Fig. 131.



Development of Gregarina.

more or less considerable part of its body. Then the posterior part of the body may be often seen to throw itself out laterally by a brusque and instantaneous movement, forming an angle with the anterior part. 3. Owing to the contractions of the body the granules within the body move about.

Development. The history of Gregarina has been worked out by Siebold, Stein, Lieberkuhn, and more recently by E. Van Beneden. The course of development is as follows: the worm-like adult, *G. gigantea* (Fig. 131, K, *n* nucleus, L, two individuals natural size), which is common in lobsters on the European coast in May, June and August, becomes encysted in September in the walls of the rectum of the lobster, the cysts (Fig. 131, A) appearing like "little white grains of the size of the head of a small pin." When thus encysted the animal loses its nucleus, and the granular contents of the cyst divide into two masses (B), like the beginning of the segmentation of the yolk of the higher animals. The next step is not figured by Van Beneden, and we therefore introduce some figures from Lieberkuhn which show how the granular mass breaks up into zoospores (called by authors "pseudonavicellæ," and by Lieberkuhn "psorosperms") with hard shells. After the disappearance of the nucleus and vesicle, and when the encysted portion has become a homogeneous granular mass, this mass divides into a number of rounded balls (Fig. 131, C). These balls consist of fine granules, which are the zoospores in their first stage (Fig. 131, N). They then become spindle-shaped (O), and fill the cyst (Fig. 131, M), the balls having meanwhile disappeared. From these zoospores are expelled Amœba-like masses of albumen (D, E) which, as Van Beneden remarks, exactly resemble the Protamœba already described. This moner-like being, without a nucleus, is the young Gregarina.

But soon the Amœba characters arise. The moner-like young (Fig. 131, D, E) now undergoes a further change. Its outer portion becomes a thick layer of a brilliant, perfectly homogeneous protoplasm, entirely free from granules, which surrounds the central granular contents of the cytode (Hæckel) or non-nucleated cell. This is the Amœba stage of the young Gregarina, the body, as in the Amœba, consisting of a clear cortical and granular medullary or central portion.

The next step is the appearance of two arm-like projections (Fig. 131, F), comparable to the pseudopods of an Amœba. One of these arms elongates, and separating forms a perfect Gregarina. Soon afterwards the other arm elongates, absorbs the moner-like mass and also becomes a perfect Gregarina. This elongated stage is called a Pseudofilaria (Fig. 131, G). No nucleus has yet appeared. In the next stage (Fig. 131, H, *n*, nucleus) the body is shorter and broader, and the nucleus appears, while a number of granules collect at one end, indicating a head. After this the body shortens a little more (I, J), and then attains the elongated, worm-like form of the adult Gregarina (K). Van Beneden thus sums up the phases of growth:—

1. The Moner phase.
2. The generating Cytode phase.
3. The Pseudo-filaria phase.
4. The Protoplast* (adult Gregarina).
5. The encysted Gregarina.
6. The sporogony phase (producing zoospores).

It seems evident that the mode of development of the Gregarina in part corresponds quite closely with the mode of growth of the Moners; for example, it becomes encysted, *i. e.*, sexually mature, produces zoospores (pseudonavicellæ), and from these zoospores issues the young or larval form of the Gregarina. These zoospores abound in damp places and are devoured by insects and worms. After they are swallowed the shells burst and the Amœba-like young are set free in the body of their host.

It will be seen that there is here a total absence of sexual reproduction. The Moner-stage arises by self-division of the contents of the cyst, a process analogous to the segmentation of the yolk of eggs; and the Pseudofilariæ arise by self-division of the young in the Moner-stage, *i. e.*, by a budding process.

LITERATURE.

Dufour. Note sur la Grégarine. (Annales des Sciences Naturelles, xiii. 1828.)

Siebold. Beiträge zur Geschichte wirbelloser Thiere. 1839.

Stein. Ueber die Natur der Gregarinen. (Muller's Archiv für Anatomie. 1848.)

Kölliker. Beiträge zur Kenntniss niederes Thiere. (Siebold und Kölliker's Zeitschrift 1. 1849.)

Lieberkuhn. Evolution des Grégarines. (Mémoires couronnés de l'Académie Royale de Bruxelles, xxvi. 1855.)

E. Van Beneden. On a New Species of Gregarina to be called *Gregarina gigantea.* (Quart. Journ. Microscopical Science. x. 1870.)

——— ——— Recherches sur l'Evolution des Grégarines. (Bulletins de l'Académie Royale de Belgique. xxxi. 1871.)

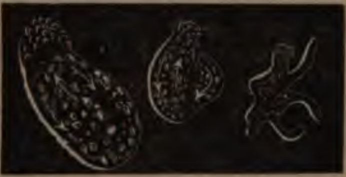
---

*The Gregarinæ and Amœbæ constitute Hæckel's group of *Protoplasta.*

III. THE RHIZOPODA.

Structure and Habits. We have almost anticipated a definition of the Rhizopoda, of which the Amœba, or Protean animalcule, is the simplest form, by our frequent references to the "Amœba-form" or "Amœba-like" stages in the Monera and Gregarinas. The Amœba is the starting point, the unit of the nucleated Protozoa, the primitive, ancestral form to which the members of the subkingdom may be reduced. Until the Monera were discovered the Amœba was regarded as the lowest possible animal.

Fig. 132.



Amœba.

With the form of the Monera, a shapeless mass of protoplasm, changing each instant, throwing out threads or larger protrusions of the body, the Amœba possesses a distinct organ, the nucleus, and its body mass is divided into a clear cortical and a medullary granular mass; the outer highly contractile, the inner granular portion acting virtually as a stock of food. These granules, like the grains of chlorophyll in vegetable cells and Diatoms and Desmids, circulate in regular fixed currents, according to J. H. Clark. (See Fig. 132, after Clark; the usual form of *Amœba diffluens* Ehrenberg, magnified 100 diameters; the arrows indicate the course of the circulating food. The head end is knobbed, and within free from granules.) We have then in Amœba:—

1. A nucleus, probably representing the nucleus and ovary of the Infusoria.
2. A head and posterior end.
3. A circulation analogous to that of the Infusoria.

This animal, as we may justly call it, since it takes in living protozoans and rejects their shells, has the power of moving in a particular direction, one end of the body always advancing first; which indicates the rudiments of a nervous and muscular power; and can swallow, digest and circulate its food. Whether it gives out nitrogen and absorbs oxygen or not is unknown. It reproduces by self-division, and some allied forms by the production of monad-like, flagellate spores.

The Amœba is a fresh-water form, living on the stems and leaves of fresh-water plants. The late H. J. Clark, our most eminent microscopist, thus describes its habits in his "Mind in Nature." "The three figures represent the various forms which I have seen the same individual assume, whilst I had it under the microscope, as it crept over the water-plants upon which it is accustomed to dwell. The most usual form which it assumed is that of an elongated oval (A), but from time to time the sides of its body would project either in the form of simple bulgings (B), or suddenly it would spread out from several parts of the body (C), as if it were falling apart; just as you must have seen a drop of water do on a dusty floor, or a drop of oil on the surface of water; and then again it retracted these transparent arms and became perfectly smooth and rounded, resembling a drop of slimy, mucous matter, such as is oftentimes seen about the stems of aquatic plants."

Pelomyxa (Fig. 134) is a fresh-water Amœba-like form, but provided with spicules. Under the name of *Amœba sabulosa* Prof. Leidy describes* a form which he thinks "is probably a member of the genus Pelomyxa," and which is characterized by the comparatively enormous quantity of quartzose sand which it swallows with its food. "The animal might be viewed as a bag of sand!" It is from one-eighth to three-eighths of a line in diameter, and was found on the muddy bottom of ponds in Pennsylvania and New Jersey. It is possibly *Pamphagus mutabilis*, figured by Professor Bailey in the "American Journal of Science and Arts," 1853. Another form resembling Greef's Pelomyxa, and found by Professor Leidy in a pond in New Jersey, is *Deinamœba mirabilis;*† its body bristles with minute spicules. He has also described in the same Proceedings (p. 88) *Gromia terricola*, which lives in the earth about the roots of mosses growing in the crevices of the bricks of the pavements of the streets of Philadelphia. He thus graphically describes this singular form. "Imagine an animal, like one of our autumnal spiders, stationed at the centre of its well spread net; imagine every thread of this net to be a living extension of the animal, elongating, branching, and becoming confluent so as to form a most intricate net; and imagine every thread to exhibit actively moving currents of a viscid liquid both outward and inward, carrying along particles of food and dirt, and you have some idea of the general character of a Gromia."

---

* Proceedings of the Academy of Natural Sciences, Philadelphia, 1874. p. 86.
† l. c. p. 142.

A convenient division of the Rhizopods is into two groups, Foraminifera and Radiolaria. Schultze divides the former into :—

1. *Nuda*, or naked forms, such as Amœba and Actinophrys.

2. *Monothalamia*, forming a one-chambered shell, but with the animal undivided, living in the simple hollow of the shell. Fresh-water forms are Arcella, Difflugia and Gromia, while Cornuspira is a marine form.

3. *Polythalamia*, with many-chambered shells; all marine. The three divisions are represented by (1) Acervulina, (2) Nodosaria and (3) Miliola, Rotalina, Globigerina, Textularia, Nummulina, Polystomella, etc.

The Rhizopods are divided by Hæckel into 1. *Acyttaria*, or the one and many chambered Foraminifera; 2. The *Heliozoa*, represented by *Actinosphœrium* (*Actinophrys*) *Eichhornii*, or sun-animalcule; and 3. The *Radiolaria*. These last two groups he divides (*a*) into the *Monocyttaria* (represented by Cyrtidosphæra, Thalassicolla and Acanthometra, etc.) and (*b*) the *Polycyttaria*, represented by Collozoum, Sphærozoum and Collosphæra. Hæckel, who has studied these Radiolaria more than any one else, though Johannes Müller gave us the first definite information about them, says that "in the lower forms they are allied to the sun-animalcules and Foraminifera, but the higher forms are much more highly developed. They differ from both the Actinophrys and Foraminifera, in that the central part of the body is made up of many cells, and is surrounded by a strong membrane. This closed, more or less spherical "central capsule" is surrounded by a slimy layer of protoplasm, from which thousands of very fine threads radiate, and often branch out and anastomose. Among them are scattered numerous yellow cells, which contain starch granules." (Whether these yellow cells are parasitic organisms, or belong to the animal, is not yet known.) Most Radiolaria are provided with a highly developed silicious frame-work, like the outer shell of a nest of Chinese carved balls, the outer surface of which is studded with spines; but both the form of the silicious box and the spines varies greatly, as may be seen by a glance at the plate in volume III* (after J. Müller), illustrating the Polycystina. Some Radiolaria have a many chambered shell like those of the Polythalamia.

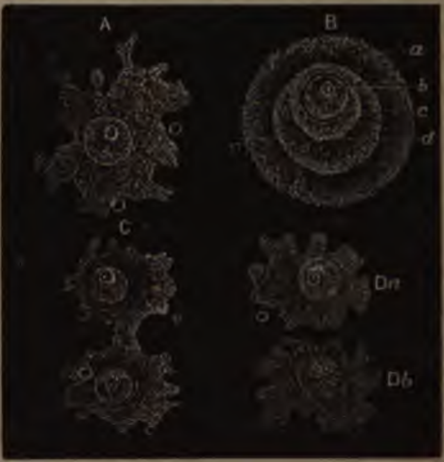
---

* Explanation of the plate. Fig. 1, *Tetrapyle octacantha*; Fig. 2. *Haliomma amphidiscus*; Fig. 3, *Haliomma longispinum*; Fig. 4, *Haliomma hexacanthum*; Fig. 5, *Haliomma?*

While the Foraminifera live mostly at the bottom of the sea (some, however, occurring between tide marks) on stones and seaweeds, creeping over sand and mud by means of their pseudopods, the marine Radiolaria for the most part float with outstretched pseudopods on the surface of the sea. They occur in countless numbers, but are usually so small that until 1858 they had been almost entirely overlooked by naturalists. The compound, or social forms, such as Collosphæra, are nearly an inch in diameter, while most of the simple species cannot be seen with the naked eye. The Polycystina occur fossil in abundance at Barbadoes, Richmond, Va., and the Nicobar islands.

Development. So far as is known Amœba multiplies its kind only by the simplest mode of reproduction known, that of self-division. The following figure (133), copied from Hæckel, represents

Fig. 133.

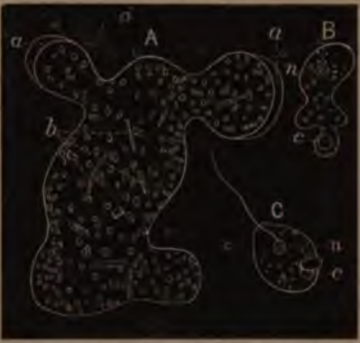


Amœba sphærococcus.

highly magnified, *Amœba sphærococcus*, a fresh-water species without a contractile vesicle, in the process of fission; at B is the encysted Amœba in its "resting stage." It now consists of a spherical lump of protoplasm (*d*), in which is a nucleus (*c*) with its nucleolus (*b*) and the whole surrounded by a cyst or cell-membrane (*a*). It breaks the cell-wall and becomes free as at

A. Self-division then begins as at C, the nucleus doubling itself, until at *Da* and *Db*, we have as a result two individuals.

Fig. 134.



Pelomyxa palustris.

In Pelomyxa, a higher form than Amœba, we have according to Greef a production of ciliated zoospores. This form, described by Greef under the name of *Pelomyxa palustris* (Fig. 134, A, *a*, clear portion; *b* diatoms enclosed in the body mass), lives in the mud at the bottom of pools, and when first seen resembles little dark balls of mud ·04–·05 inch in diameter. The body mass contains numerous vacuoles filled with water, and numbers of nuclei and spicules. These nuclei and spicules have a dancing motion, like the ordinary Brownian movements of molecules. There are also numerous hyaline, oval or rounded bodies which Greef calls "shining bodies," and which originate from the nuclei. They increase by division within the body-mass of the Pelomyxa, becoming Amœba-like bodies (Fig. 134, B, *n* nucleus, *c* contractile vesicle) which issue in great numbers from the parent-mass. These Amœboid forms gradually pass into flagellate zoospores (Fig. 134, C) with a nucleus and contractile vesicle. It thus seems that the zoospores of this Rhizopod are produced without the animal becoming encysted.

As regards the development of Actinophrys and the allied spiny forms, Greef thinks that besides being formed by direct self-division, there is a resting or encysted stage. "The latter consists in the withdrawal of the sarcode body-mass from the inner boundary formed by the union of the bases of the radial spines, leaving a rather wide empty border, and its becoming invested by a double coat, viz., a firm inner one, when empty, dotted, as if perforated, and an outer hyaline one."

According to Schneider, *Actinophrys Eichhornii* undergoes division; the central mass divides twice or thrice. Then the alveolar cortical layer disappears, and each mass resulting from the self-division becomes encysted. This process is undergone in two days. It remains encysted through the winter until the beginning of May, when the cyst drops off and a small Actinophrys with a number of nuclei appears.

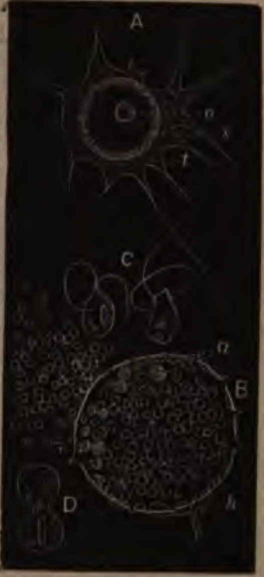
As an example of the reproduction of these forms by fission, we may cite the case of *Gromia socialis*, figured by Archer. He represents the body of a Gromia after having undergone a transverse self-fission, having in each portion a nucleus with its nucleolus, the upper segment giving off branched pseudopodia as usual.

Of the mode of development of the shelled Amœbæ or Foraminifera (Polythalamia), numerous and often accessible as these animals are, we know but little. In fact, we have only the fragmentary observations of Max Schultze, made in 1856, on a species of Miliola sent him from Trieste. He says that this Foraminifer, after remaining from eight to fourteen days in the same place on the side of the jar, became surrounded with a thin layer of brownish mud, so that the shell was lost to view. On the 15th of May he noticed that small, round, sharply defined bodies escaped from the brownish slimy mass, and after some hours as many as forty such bodies surrounded the Miliola. These round bodies were young Foraminifera in calcareous shells with one turn, but no inner walls, somewhat resembling Cornuspira, and with pseudopodia already like those of the adult. It is probable, therefore, that the shell of the young is formed within the parent. Schultze adds that the almost complete want of organic contents in the shell of the parent at this time, rendered it probable that the whole or greater part of its body had passed into those of the young.

Of the mode of development of the Radiolaria, Prof. Cienkowski afforded, in 1871, the first definite information. He states that "J. Müller saw in the interior of an Acanthometra a swarming of small monad-like vesicles, which moved about for a time, and then changed themselves into Actinophrys-like structures. Afterwards," Hæckel saw, first, in Sphærozoids, "the contents of the capsules break up into many vesicles, and secondly, in Sphærozoum, he observed masses of vesicles which exhibited a vibratory movement." Lastly, Schneider had noticed in Thalassicolla groups of amœboid vesicles with movable flagellum-like processes. These facts rendered it probable, what Cienkowski has proved, that the Radiolaria reproduce by motile germs, *i.e.*, zoospores.

He studied the compound forms, such as Collosphæra and Collozoum, which are composed of aggregations of capsules (Fig. 135 A, a capsule of a young Collosphæra without the latticed shell), held together by a common mass of protoplasm. These capsules are separated by a certain interval from one another, while the protoplasm binding them together consists of alveoli (vesicles) of various sizes, between and on to which sarcodic threads and networks are disposed. "I always found," he adds, "the capsules supported on the surface of the alveoli, often lenticular, compressed, and enclosed by a radiating layer of protoplasm, which also spreads itself over the alveoli, and passed over continuously into the sarcodic envelope of neighboring capsules. Besides those alveoli which carry capsules, there are many smaller, which are free from capsules."

Fig. 135.



Collosphæra.

Collosphæra spinosa (Fig. 135, B) possesses a fenestrated shell beset with small spines, which encloses a capsule with a protoplasmic investment. Fig. 135, B, *a*, indicates the problematical yellow cells. Fig. 135, A, indicates a young capsule of another spineless species, *C. Huxleyi* Müll. The young capsule of this species is naked, embedded, without any shell, in a radiated protoplasmic sheath, not emarginated by any sharply marked envelope. "In this stage they often divide themselves by fission into two halves. Not until maturer age does the capsule obtain a resisting membrane, and become enclosed in a fenestrated shell.

The next change which takes place in the capsule is its division into a number of little spheroids. This process is accomplished in a single day in *C. Huxleyi*. These spheroids become monad-like bodies, filling the capsule with a mass of corpuscles having a tremulous movement, and which finally swarm out in all directions (Fig. 135, B) from the capsule as true zoospores (C). The capsules now die and break up. These zoospores are provided with two long cilia. In the interior are a few oil drops, and a little crystalline rod, which sometimes projects out of the body.

"Among the swarms of swimming zoospores lay many motion-less ones dispersed," continues Cienkowski. "They were round or angular, with drawn-out points," and one or more constrictions could be seen in them (Fig. 135, D). "Apparently they were developmental stages of the zoospores, obtained as they were in course of formation from the contents of the capsule." Cienkowski observed the same process in *Collozoum inerme*, thus substantiating his observations on Collosphæra.

In the Rhizopods, then, we know certainly two modes of reproduction:—

A. By self-division, as in Amœba.

B. By the production of zoospores, as in the Radiolaria.

In the latter the following phenomena take place:—

1. The capsule is filled with spheroids by a probable division of the contents of the capsule, as in the encysted stage of Moners and Gregarinida.

2. The "out-swarming" of zoospores.

LITERATURE.

A. Naked Rhizopods.

Auerbach. Ueber die Einzelligkeit der Amœben. (Siebold and Kölliker's Zeitschrift. 1855.)

Kölliker. Das Sonnenthierchen, *Actinophrys sol.* (Siebold and Kölliker's Zeitschrift. 1849. Translated in Quart. Journ. Micr. Science. 1853.)

Clark. Mind in Nature. 1865.

Archer. On some fresh-water Rhizopoda, new or little known. (Quart. Journ. Micr. Sc., 1869–71.)

B. Foraminifera.

Schultze. Ueber den Organismus der Polythalamien nebst Bemerkungen über die Rhizopoden in Allgemeinen. 1854.

——— Beobachtungen ueber die Fortpflanzung der Polythalamien. (Müller's Archiv für Anatomie, etc. 1856.)

Carpenter. Researches on the Foraminifera. (Philosophical Transactions of the Royal Society. London, 1856–7.)

C. Radiolaria.

Müller. Ueber die Thalassicollen, Polycystinen und Acanthometren des Mittelmeeres. (Abhandlungen der K. Akad. Berlin, 1858.)

Hæckel. Die Radiolarien. Eine Monographie, folio, 1862.

Cienkowski. Ueber Schwärmerbildung bei Radiolarien. (Schultze's Archiv für Mikros. Anatomie, VII, 1871. Translated in Quart. Journ. Micr. Sc., 1871.)

Schneider. Zur Kenntniss der Radiolarien. (Siebold and Kölliker's Zeitschrift. xxi, 1871.)

REVIEWS AND BOOK NOTICES.

Introduction to General Biology.*—Though the plan of this little manual is good, being identical with the arrangement of the examination questions in the Science and Art Department of Instruction at South Kensington, we cannot speak favorably of its execution, or advise the use of the book in this country, unless carefully revised. A want of special knowledge of the subject, and the usually execrable woodcuts, wherever not copied from other works, detract seriously from the value of the book.

Publications of Wheeler's Survey.†—Besides the maps issued by this survey we now have a Catalogue of Plants collected in the years 1871, 1872 and 1873, with descriptions of a few new species, by Mr. Sereno Watson and Dr. J. T. Rothrock, botanist, aided by Messrs. Hoopes, Olney, Vasey, Eaton, James and Austin. The report upon the birds collected in Utah and Nevada during the same years, by Dr. Yarrow, abounds in notes on habits and geographical distribution.

The Geological Survey of Indiana.‡—While this last year's report of the Survey is mainly on economic geology, as it should be, it contains some archæological and palæontological notes of interest.

BOTANY.

Yucca filamentosa.—Dr. Engelmann's interesting observations on the genus Yucca, and Prof. C. V. Riley's discoveries in relation to the yucca moth,§ have turned attention generally to this family of plants. The *Yucca filamentosa* is the species most commonly cultivated in the central United States. It is found growing wild in Virginia and southward. The generic name *Yucca* is supposed to be of Indian origin; its signification is not known. The specific name *filamentosa* is expressive of the thread-like filaments found on the edges of the leaves. The popular names of this plant are Spanish bayonet, Adam's needle and bear grass. The name first mentioned was probably suggested by the form of the leaves. In the backwoods of West Tennessee this yucca is called "bar grass," "bar" probably being the rural for bear; the tough leaves are used there for suspending meat in the smoke-house. The peculiar perfume of the flowers of this plant is not perceptible in the daytime. I have known floriculturists who have had the plants in their gardens for years without discovering that they possessed fragrance. In this latitude, Jacksonville, Ill., the perfume begins to exhale about 7 o'clock, P. M. It is sufficiently like that given off from a wasp when disturbed, to make nervous persons uneasy if unacquainted with its origin. It is worthy of note that the Yucca moth makes its appearance on the plant soon after its perfume becomes perceptible. This summer, having a blooming plant of the *Y. filamentosa* in my garden, I determined to see what I could of its wonders for myself; my tools were a simple hand microscope and a number of little tarlatan bags with draw strings. With the latter, four experiments were tried. The first one was to test the ability of the flower to pollenize itself. Four large buds on different branches and almost ready to open, were selected, a bag was drawn over each of these and fastened by the draw string to the stem beyond the flower. With the view of throwing as much strength as possible into the flowers operated on, all the other flowers on these branches were removed. The buds expanded in their gauzy covering as perfectly as their unveiled sisters, but like nuns of another order they drooped and died, leaving no progeny behind them. The second experiment was to pollenize the flower, by itself, artificially. The buds were gently opened and some pollen scraped from their anthers with a small penknife and placed in the entrance to the stigmatic tube. The buds were then enveloped in bags and the branches stripped off the other flowers and buds as in the former case. These also failed to develop seeds. The third experiment was to pollenize artificially from another plant. The operation was conducted like the above, and like the above failed to produce seeds. The fourth experiment was to pollenize artificially from other flowers on the same plant. One large perfect capsule of seed resulted from this attempt. In this capsule the indentations around the middle, which forms so constant a feature in this species was not present. Was this variation from the usual form the result of unusually perfect fertilization, or from the protection from the puncture of insect afforded the seed-pod by the gauze? This peculiarity of the seed-pods of the filamentosa calls for further investigation. If it be a development of the natural growth of the plant and not caused by external agencies, it is interesting to note how it may be made to vary as in the above case. If it be caused by deficient fertilization or from the puncture of insects, why are the indentations so uniformly in the middle of the capsule?

---

* An Introduction to the Study of General Biology, designed for the use of School and Science Classes. By Thomas C. MacGinley. With 124 illustrations. Putnam's Elementary Science Series. New York, G. P. Putnam's Sons. 12mo. pp. 199. Price 75 cts.

† Report upon Ornithological Specimens collected in the years 1871, 1872 and 1873. By Dr. H. C. Yarrow. Washington, D. C. 8vo. 1874. pp. 148. Catalogue of Plants collected in the years 1871, 1872 and 1873, with descriptions of New Species. Wheeler's Geographical and Geological Explorations and Surveys West of the 100th Meridian. Washington, D. C. 1874. 8vo. pp. 62.

‡ Fifth Annual Report of the Geological Survey of Indiana, made during the year 1873. By G. T. Cox, State Geologist, assisted by Prof. John Collett, Prof. W. W. Borden and Dr. G. M. Levette. Indianapolis, 1874. 8vo. pp. 494. With plates and maps.

§ Trans. St. Louis Acad. Science, 1873, and American Naturalist, vol. 7.

In the three experiments where pollen was used, the pollen was placed as nearly as possible in the same position in each flower, viz., just at the entrance to the stigmatic tube; the result confirms the view taken by Dr. Engelmann in relation to the difficulty of this flower being pollenized by other natural agencies than that afforded by the yucca moth. She thrusts her mass of pollen far into the stigmatic opening, thus insuring fertilization. If, as is probable, the yucca plant preceded the yucca moth in existence, the plant is so prolific in bloom and in seeds, that if but a very small proportion of the flowers were fertilized by the usual agencies, there would still be enough seeds produced to perpetuate the species abundantly; for each capsule contains from one to three hundred seeds. After the seeds on my plant had turned black and before the yucca grubs had eaten out, forty-one capsules were carefully examined, of these twenty-four contained grubs, one held six of the little fellows. In no case was there more than one grub found in the same end of a row of seeds, occasionally one was found at each end of a row and the grubs were found quite as often at one end as at the other of the capsules. My plant was frequently disturbed. It would appear from the unusually large proportion of capsules without grubs, that the moth may be more successful in fertilizing the flowers when disturbed, than in finding a safe harbor for her eggs. If the discoveries made in regard to the fertilization of this plant can be sustained on further investigation, more than ordinary intelligence must be ascribed to the yucca moth, 1st, for her foresight in making ready the way for her progeny to be supported, and this, by *indirect* means; 2nd, in her wise disposition of her eggs so that the larvæ cannot interfere with each other's supply of food. May not this little insect while fluttering around within the flower, seeking a place to deposit her eggs, accidentally become laden with pollen? Then, when her work is done and she ascends the stigma to regale herself with its sweets, she brings her pollen-laden antennæ in contact with the stigmatic surface, thus unwittingly performing her part in this life drama.—J. M. MILLIGAN.

THE DISTINCTIVE FEATURES OF APPLE FLOWERS. — We make a brief abstract of an essay on this subject by Prof. W. J. Beal, of the Michigan Agricultural College. The essay is contained in vol. iii of the Report of the State Pomological Society. Each flower bud of the apple contains five to eight flowers. The centre flower opens first, and is often provided with poor anthers; it is most likely to set for fruit so far as the author has observed. The immense number and often very great similarity of varieties of apples make it often difficult to recognize and define them by the fruit alone, as is mostly done. No pomologists that he could hear of have made any use of the flowers of apples as a means of classifying them. He says, "the petal of the red astrachan is one and a fourth inches long by three-fourths broad. It is ovate. The petal of a Tolman Sweet is twelve-sixteenths by seven-sixteenths of an inch, and is elliptical. Its length is about the breadth of the red astrachan. The petal of the Porter is thirteen-sixteenths by twelve-sixteenths and is nearly orbicular. It is also cordate at the base, different from the other two varieties. Large numbers of flowers were examined on several trees of each, except the Porter. The petal of the sweet bough is seventeen-sixteenths by fourteen-sixteenths of an inch. It is broadly ovate, with a stem or claw longer than either of the other three varieties mentioned. Other varieties were examined with similar results. The styles also vary much in size and in other respects in different varieties. They are usually united about half-way, and mostly smooth for the greater part of their length. In the Tolman Sweet, the styles are united in one small column for half their length, then appear larger. The upper half of the styles are closely covered and bound together by a dense woolly substance, unlike the styles of any other variety examined. The sepals also differ considerably in different varieties." The author is confident that much use can be made of the flowers in defining varieties of apples. This may seem a simple matter to botanists, but it must be new to most pomologists, for some of the best of them say there is little difference in the flowers of apples.

ZOOLOGY.

NOTE ON THE SYNONYMY OF TELEA POLYPHEMUS.*—In a paper read before the Royal Dublin Society, March 18, 1872, Mr. W. F. Kirby prefers the name *paphia* L., for our common species of Telea, and says: "It has, I think, been questioned whether Cramer's *Attacus polyphemus*, from Jamaica, is identical with this common species." It is Dr. Packard who writes of Cramer's figures under the names "Cecropia," "Polyphemus" and "Promethea," as received from the West Indies, that they "would lead one to suppose that they represented distinct species," from those we know from the United States under these names (Proc. Ent. Soc. Phil., 1864, p. 381).

Having received *Telea Polyphemus* from Matamoras, collected by my brother, Capt. F. Harris Grote, and it having been recorded from California by Mr. H. Edwards, we can assign a wide range to this species. Farther to the southward it may be replaced by the Mexican *Telea Montezuma* Grote, Trans. Am. Ent. Soc., 2, p. 118. My studies of this Bombycid lead me to believe that the typical Attaci are entirely unrepresented in the West India Islands. The positive demonstration of this as a fact would be highly interesting as throwing some light on the geological history of the Islands. I am, then, inclined to regard Cramer's habitat for our Attaci as erroneous, and to account for the discrepancies of his figures, by an infidelity of execution.

I do not find any description of a species of Attacus under the name Polyphemus by Linné. The first description seems to be that of Cramer, and the species is afterwards described under the same name by Fabricius (Species Insectorum). This corrects the synonymy proposed by Dr. Packard, who cites Linné as authority for the species, referring to the "Syst. Nat. (1767)."

Linné describes his *B. paphia* first in "Syst. N. X." 1758, as from "Guinea," p. 496, No. 4, and cites "Petiv. Gazoph." tab.

---

* I am indebted to Dr. Hermann A. Hagen of Cambridge, Mass., for bibliognostic information used in the present article.

29, f. 3, which I cannot consult and, *doubtfully*, "Catesby" Car. 2, p. 91, tab. 91. The species intended by Linné cannot, I think, be our Polyphemus.

In Mus. Lud. Ulr. 1764, p. 369, No. 4, Linné describes in extenso *B. paphia* from septentrional America, and cites Catesby, this time without doubt, as also Petiver and Rumphius. The description hardly applies to our species, but this is the only one that admits of the probability. Finally in the twelfth edition of the "Systema Naturæ," 1767, p. 809, No. 4, Linné cites Catesby *again* with *doubt*, and gives Guinea, Asia, as the habitat of his *B. paphia.*

Of his *B. paphia* (Mus. Lud. Ulr.) Linné says: "Ocellus primoris similes in medio; postice pallidiores versus marginem et obsolete undulate," and "Ocelli utriusque alæ in mare oblonga, in femina orbiculati, quorum qui in aliis posticis cincti nigr. violacea," which in part does not agree with our species.

I think, then, that the *B. paphia* of Linné's tenth and twelfth editions of his "Systema Naturæ" is not our Polyphemus, while that of his Mus. Lud. Ulr. may be. This latter will not affect the specific name of our common species, which appears to be confined to continental North America and not to occur in the West Indies.—AUG. R. GROTE.

THE REVERSION OF THOROUGHBRED ANIMALS.*—The improvement in live stock has been greater than in tillage. It has been accomplished by (1) selection of breeding animals, and (2) by care of them. Both of these are essential. Starved animals will not thrive, no matter how well bred, and no skill in care and feeding will give from poor breeds the best of animals. Special excellences are the accumulated improvements of several generations.

It is often claimed that if the care of man be withdrawn the improved breed will retrace the steps of its ancestry and revert to its original characteristics. This theory has been made a dogma and the basis of deductions regarding the permanence of original types and the fleeting nature of acquired characters. The dogma finds a place in scientific literature in papers read before learned societies, and from these sources the notion spreads through our popular literature. It has weight with a class of farmers who do not wish to expend money and care on their live stock — to have the best and care for it in the best manner. They suppose that the moment their care is withdrawn, the objects of it will begin to "revert" to original inferiority. This wide-spread belief greatly impedes the general improvement of live stock.

---

* Read at the Hartford Meeting of the Amer. Assoc. Adv. Science.

Instances of this alleged "reversion" were brought forward at the last annual meeting of this Association, and are printed among the papers then delivered. About a month later there was a meeting held in a neighboring state. Stock breeders came from England, from California, from even the very state where they had just been told that "shorthorns" were prone to return to their original state. The meeting was for the sale of improved animals, and in 30 minutes the sale of shorthorns amounted to $250,000, and there also, within a very short time, 109 head of cattle were sold for $382,000. For 5 cows — the Duchess strain — $158,000 were paid — all showing the faith of the purchasers in the permanence of the improved stock.

For some years Prof. Brewer has been investigating this subject and seeking for proof of the alleged tendency to reversion. The inquiry only covered "*thoroughbreds*," and not "grades" nor "mongrels." To carefully worded inquiries in writing, following upon every report of such "reversion," Prof. Brewer has received very numerous replies, and they are unanimously in the negative. This is certainly remarkable, following upon the confident assertions that animals so frequently exhibited the alleged tendency. The inquiries were pushed in the specific localities where the reversion was said to have occurred; the questions have been put to a large number of stock-breeders, and finally have been made by means of a printed circular. But the result was always the same, except that a smile of incredulity extended over the faces of some stock breeders when such inquiries were put to them, and they feared they were to be made the victims of a "sell." No instances of the alleged "reversion" having been authenticated in Prof. Brewer's experience, he asks the Association to aid in exposing and refuting the pernicious notion.

DEEP SEA EXPLORATIONS. — In a letter written by Professor Wyville Thompson, in charge of the "Challenger" Expedition, we have some account of the dredgings at great depths in the Antarctic Ocean. After leaving the Cape of Good Hope, several dredgings were taken a little to the southward, at depths from 100 to 150 fathoms. Animal life was very abundant, and it was found that the general character of the fauna was very similar to that of the North Atlantic — many of the species even being identical with those on the coasts of Great Britain and Norway. Between Prince Edward's Island and the Crozets they trawled in 1,375 and 1600 fathoms, and many new forms, including two stalked crinoids and some deep-sea sponges and sea-urchins, occurred. Off Kerguelen Island, a fine sponge (Rossella) — probably the *Rossella antarctica* — originally dredged by Sir James C. Ross, near the ice-barrier, was obtained. At their most southerly station — lat. 65° 42′ south, long. 79° 49′ east — the trawl brought up from a depth of 1,675 fathoms a considerable number of sponges and other deep-sea forms. Dredgings with similar results were made in 1,800 and 1,900 fathoms. Again at a depth of 2,600 fathoms Holothurians were abundant, with several star-fishes and Actiniæ and an "elegant little Brachiopod." By using the towing net from the surface as deep down as 150 fathoms, Mr. Murray, one of the party, infers "that the bulk of the material of the bottom in deep water is in all cases derived from the surface."

THE CHESTNUT-SIDED WARBLER.—In the account of the chestnut-sided warbler (*Dendroica Pensylvanica*) in vol. I of "North American Birds," Dr. Brewer states that "it is not known to breed farther south than Massachusetts." On May 19, 1871, I shot a female of this bird off a nest of four eggs, at White Sulphur Springs, West Virginia. This locality is about 2000 feet above the sea and somewhat below lat. 38. The nest was eighteen inches above ground in a small thorn bush in a swampy thicket. With the exception of being slightly smaller, and having the chestnut side streak more faintly developed this bird does not appreciably differ from specimens I have from Canada.—ARTHUR C. STARK, *Hillstead*, *Torquay*, *England*, *Oct.* 29, 1874.

EMBRYOLOGY OF THE BRACHIOPODS.—Kowalevsky has published a fully illustrated paper on this subject in the "Memoires" of the Academy of Science at St. Petersburg. It gives an account of the embryology of Argiope and other genera, and is fully corroborative of the studies of Prof. Morse and his opinion that the Brachiopods are closely allied to the Chætopod worms. A number of interesting sections of the embryo are figured. At one stage the larva would easily be mistaken for that of a worm. On another occasion he writes that "it was while fresh from the impression produced on me by the views of the American scientist that I write the last portion of my general review, although I had previously arrived myself to the conclusion, based upon the homologies of the muscles and setæ, that the Brachiopods are nearly allied to the Chætopod Annelides."

METAMORPHOSES OF THE HAIR WORM.—M. Villot is publishing a monograph of the Hair Worms in the "Archives de Zoologie Experimentale." He has found the larvæ encysted in the larvæ of Chironomus, and afterwards in the mucous lining of the intestines of fishes, in September. Thus their metamorphoses have been, in conjunction with the previous labors of Grube, Leidy, and Meissner, cleared up. The larvæ are tadpole-shaped. The habits of Gordius seem quite distinct from Mermis, found living in insects.

A NEW ORDER OF HYDROZOA. — Prof. Allman publishes in "Nature" a brief account of his discovery of a French hydroid embedded in a sponge, which he describes under the name of *Stephanoscyphus mirabilis*, and regards as the type of a new order termed *Thecomedusæ*. He regards this animal as a compound hydrozoon, "whose zooids are included in cup-like receptacles resembling the hydrothecæ of the calyptoblastic hydroids; but these zooids, instead of being constructed like the hydranths of a hydroid are formed on the plan of a medusa. It has plainly very decided affinities with the Hydroida, but it is nevertheless removed from these by a distance at least as great as that which separates from them the Siphonophora."

BIRDS OF KANSAS.—Since the publication of the second edition of my catalogue of the birds of Kansas (Oct., 1872), six additional species have been observed; viz: *Colaptes Mexicanus*, *Helmitherus vermivorus*, *Dendrœca striata*, *D. maculosa*, *Larus Delawarensis* and *Podiceps auritus* var. *Californicus*.—F. H. SNOW.

OSTRICH BREEDING.—The success which has attended the ostrich-breeding farms in South Africa has induced some French gentlemen to endeavor to imitate the system in Algeria, and African birds have also been sent to La Plata and other countries in South America, where it is hoped they may take the place of the native birds, which are inferior in quality to the African ostrich. Generally speaking, the system on which ostrich farms are conducted is as follows:—The birds kept for breeding purposes, about three years old, are placed in separate paddocks, in pairs, and their eggs are either hatched in the natural way or placed in incubators prepared for the purpose. By this means a larger proportion of eggs is hatched. The young birds are fed on grass, lucern, and other vegetable matters, and are sheltered at night. Each pair of birds will produce about twenty chickens, which may be plucked when they are about eighteen months old, before which time the feathers are not of much value. The price of good ostrich feathers, wholesale, is about 40 *l.* per pound weight. If the birds are well kept, and have plenty of exercise and food, their feathers are of good quality; but the plumage of wild birds is considered superior to that of inferior tame ones. The value of each year's plucking from the young birds is about 7 *l.*, and of the birds themselves six months old is 30 *l.* to 35 *l.* The breeding birds are worth 125 *l.* per pair.—*Nature.*

CASE OF A DOG NURSING A KITTEN. — Mr. John Downing, residing at No. 27 Morgan Street, has a female dog of some breed of setter, which has not been pregnant for upwards of three years. At her last pregnancy she gave birth to six pups, of which one only was allowed to survive; this one was continued with her only six months. Since then she has been entirely alone, and spends her days in a close yard and her nights in a house.

She has always been averse to the society of cats, repelling all their advances towards friendship. About two months ago the family procured a very small kitten, and the dog was soon observed to keep it near her, and rather tagged it around. About four weeks ago the dog was observed to be nursing the kitten, and has steadily given it milk ever since. The four posterior mammæ are a little tumefied, but the forward ones are as flat as in an unimpregnated puppy. Upon gentle pressure, an abundant flow of milk readily shows itself, and what seems remarkable, from all the teats alike. The kitten thrives vigorously, which seems to demonstrate that the milk is a normal secretion. As soon as the kitten approaches the dog, she lies down and offers herself to the kitten as to her own offspring, and the kitten purrs itself to sleep while nursing, apparently regarding its adopted mother as a perfectly normal substitute for its natural nurse. — F. H. WILLIAMS, 70 *Mulberry St., Hartford, Oct.* 26, 1874.

ANTHROPOLOGY.

THE EARTHWORKS OF "FORT ANCIENT."—On the 16th of June, 1869, I found myself in the neighborhood of the famous "Fort Ancient," on the little Miami River, some four miles above the town of Morrow in Warren County, Ohio; and as a day's leisure was left me I determined to visit these interesting remains of the prehistoric tribes of America. The following notes additional to those made by previous visitors may be of interest. With a tracing in my hand of the survey of Dr. Locke, as given in the first volume of the Smithsonian Contributions, I ascended the road leading eastward from the railroad station and entered the fortifications at a point which is said to have been an original outlet, but which has been so enlarged for the use of the present roadway that its original facing is now gone. The excavation thus made has revealed a section which shows that the earthwork was originally begun by building an exterior retaining wall, two to four feet high, of flat stones.

The outer parapet of the fort was now followed by me with great faithfulness entirely around the enclosure. Descent was made into each and every ravine, and the whole examined as carefully as was possible for one person to do in about five hours; it will be remembered that twelve persons were occupied two days in making the survey published by Dr. Locke.

The principal new features that I noted may be summed up as follows:

1. The retaining wall above mentioned.

2. Certain outlets, twelve in number, are not for drainage purposes. On the contrary, they invariably have on the inside a raised pathway crossing the interior ditches and connecting the outlet with the interior of the fort, and on the other hand they open exteriorly not into a ravine, but upon the crests of ridges dividing two ravines.

3. The breaks in the continuity of the parapet may therefore be divided into two classes. First, the just mentioned actual gateways opening out upon crests of ridges, and second, sluices for drainage—whence many of the small streams take their rise.

The engraving given by Dr. Locke, therefore needs correction in these particulars.

Of the seventy breaks in the parapet not more than twenty were used as gateways.

4. The gateways are distinguished by having their floors elevated above the natural surface of the ground both outside and inside of the parapet; they were also probably all faced and paved with stone, as remains of these stone facings are often seen, and the facing and paving of one of the gateways are still almost perfectly preserved.

5. At one point there are plain traces of a stone pathway (probably originally stone steps) leading for a long distance from a gateway down the crest of the ridge towards the brook that empties into the little Miami.

6. The ravines of the western side of the northern half of the fortification had been so filled with brush that it was impossible for me to examine them as thoroughly as was desirable, or to visit the well near by.

7. The entire interior of the northern half of the fort is now under cultivation, and the plough has revealed two large piles of stones at one spot.

8. There are but two instances of recent gullies cut through the embankments, and the ravines are now in very nearly the same condition as when the work was built. Only in four places are the original ravines perceptibly deeper than when the work was deserted.

9. Many holes have been dug by treasure-seekers, especially by a person from Lebanon, who is continually resorting hither with a hazel rod in his hand.

10. Two mounds are to be found in the woods on the south and east of the fortification as reported to me by the farmer living in the neighboring house on the Chillicothe road, but I had not time to hunt for them.

11. An oak tree on the northern face of the embankment was recently cut down having five hundred rings counted by Hon. E. D. Mansfield, in 1855.

12. No stone implements were found nor any traces of them.

13. The general impression that one must receive from the study of this remarkable earthwork is that it was once the defence of a walled town,—that it was not a hasty construction, nor soon abandoned, but was occupied for a long period. The central neck is so well guarded at both its ends, as well as its sides, that it would

seem as though the inhabitants had provided for a retreat in case of the capture of either half of the town. The southern half is far better defended, naturally, by ravines and steep inclines, and artificially by its double walls, so that this may well have been the first home of the people who, afterwards, extended the limits of their walled town northwards. The weakest portion of the fortress is on its northeastern side where the artificial embankments are unusually high and steep, and where the main gateway opens out upon a broad level field on which is erected the mysterious enclosure whose outlines are given by Locke. The mound at the farther end of this enclosure I should say might well have served as a watch-tower either for the besieged or the besiegers,—its parallel walls affording means of escape and of defence. It is not clear to me but that the forest may have been allowed to stand both within and without the fort, even during its occupation, the trees being indeed an advantage both as protection against sun and wind, and as affording great help in actual combat.—CLEVELAND ABBE.

[Being unable to reproduce Mr. Abbe's drawings we have omitted his letters of reference.—EDS.]

MICROSCOPY.

DISTRIBUTION OF THE RHIZOPODS.—At a meeting of the Academy of Natural Sciences of Philadelphia Prof. Leidy remarked that while it was exceptional to find the same species of the higher sub-kingdoms in the different parts of the world, it appeared to be the rule that most species of Protozoa were found everywhere under the same conditions. A large number of our fresh-water forms he had recognized as the same as those described by European authors. A less number of species are probably peculiar to every region. Among our fresh-water Rhizopods he had observed not only the genera Amœba, Arcella, Diffugia, Euglypha, Trinema, Lagynis, Actinophrys, etc., but also most of the species of these as indicated by European naturalists. It is an interesting question whether our fresh-water Protozoa have reached us from the same sources as those of Europe and other remote countries. If derived from the same sources they were probably infused in the waters of the different continents at an early age when the latter were not separated by ocean barriers. If thus early infused we have a remarkable instance of a multitude of specific forms retaining their identity through a long period of time. Such a view might appear to oppose the doctrine of evolution, but not justly so, for the simplest forms would be the slowest or least likely to vary, while the most complex, from their extended relationships, would be most liable to variation. Perhaps, however, the simplest forms of life, of the same species, may have originated independently of one another, not only in different places, but also at different times, and may yet continue to do so. While the highest forms of life may have been slowly evolved from the simplest forms of the remotest age, equally simple forms may have started into existence at all times down to the present period. From the later original forms new ones may have been evolved to speed towards the same goal as those which preceded them.

NOTES.

In an article in the "North American Review" entitled "Exact Science in America," Mr. Simon Newcomb concludes that "we are a generation behind the age in nearly every branch of exact science." He attributes this to the want of effective organization and incentive rather than to our lack of zeal in developing the material resources of the country. This statement also applies in a measure to biological science. How far the state and national geological and biological surveys have served, instead of any more direct and effective means of organizing scientific efforts, would be an interesting inquiry. As it is, the national and several state geological surveys have been almost the only means of educating students in science, of bringing to a focus the labors of scattered scientists, and of placing before the people the results of the examinations with more or less care of the geology and natural productions of our states and territories. Look, for example, at the Geological Survey of the state of New York. By the wisdom and liberality of the legislature of that state, a series of volumes on the geology, agriculture, palæontology, zoology and botany of that commonwealth have been issued, which have altogether immensely advanced these sciences in this country and assured European naturalists that in native ability and power of observation and of producing useful results from abstruse knowledge the American is not behind his trans-Atlantic brother in science. That survey also called in the aid of some eminent European naturalists, established a large museum, one of the finest in the world, and a body of assistants who have formed a coterie or school of observers, which have done and are doing much to elevate the standard of pure science in our country. The Coast Survey in like manner, and the survey of the Territories, have built up centres of science and gathered at Washington a number of scientists, which have made that city second to no other scientific centre in the United States, and developed the energies and collected the results from observers scattered over the country. The direct influence of surveys, geodetic, geographical, and geological, in developing our science is most apparent. Certainly our colleges and universities thus far have not proved to be centres for the advancement of science; they tend to act rather as conservators of knowledge. Exception should of course be made for Harvard and Yale.

It is not to be overlooked that some of the most talented observers are not connected with any college or survey, and science has been largely indebted to isolated students for her most valuable discoveries. But it is to state and government surveys that America is on the whole most indebted for her present scientific position; in other words to *grants of money and incentives to work from the people.* It is for this reason that the proposal on the part of a number of the scientific citizens of the state of Massachusetts, who lately had a hearing before the State Committee on Education in regard to a re-survey of the topography, geology and biology of the state, will we hope, meet with favorable action on the part of the legislature this winter. By the annual appropriation of $20,000 for a period of fifteen years, a careful, elaborate and most useful survey of that small state can be made. No survey has been made for nearly forty years. The value of the brief and incomplete reports published by the state, about forty years since, *i. e.* the botanical works of Mr. G. B. Emerson, Gould's "Invertebrates of Massachusetts," Storer's "Fishes of Massachusetts, and Harris' "Treatise on the Injurious Insects of the State," —the value of these, not to speak of the other excellent reports, as educational works, in making students of science, in assisting state teachers and in aiding farmers and gardeners in combating injurious insects, cannot be overestimated.

So valuable have these works been considered, that the state reprinted those of Drs. Gould and Harris at a cost of $20,000. Every motive of state pride and economy calls for a thorough and final survey of the state, with reports on all departments of science, botanical and zoological as well as geological and topographical. Several other states, as Pennsylvania, Kentucky, North

Carolina and others, are making re-surveys. Such a survey, comprehensive and thorough, embracing biology as well as physical geography and geology, can be done much cheaper than many may think. The work can be accomplished as in the past, largely by naturalists and students without pay. Many monographs on groups of animals and plants, private geological explorations and the coast survey triangulations already made can be worked in without cost. The final reports can be sold at cost, and thus repay the original outlay in printing them. Those of some states have already more than repaid the cost of publication. It is to be hoped that the biological side of the survey will be fully attended to. There is a pressing need among our agriculturists of a knowledge of our parasitic plants and injurious animals.

The amount of produce annually raised in the United States is $2,500,000,000. It is estimated that we lose one-fifth of this amount, or $500,000,000, from the attacks of injurious plants and animals. Of this amount certainly one-tenth, or $50,000,000 could be saved with a proper knowledge on the part of our agriculturists of the forms and habits of the injurious species. In one year it is said that in the Eastern counties of Massachusetts the farmers lost $250,000 worth of grass from the attacks of the army worm. In 1871, in Essex County alone, $10,000 worth of onions were destroyed by a minute insect; a loss that a slight knowledge might readily have prevented. We need state aid in affording the means of importing and raising certain parasitic insects which prey on the injurious forms. In a money point of view the natural history side of the proposed survey is fully as important as the geological or topographical.

Moreover the biological department of the survey could be carried on at a slight expense compared with the topographical and geological; and the reports, if properly illustrated and containing notes on the modes of living of injurious plants and animals, would, we doubt not, fully repay the original cost of printing.

THE attempt to colonize the bay of San Francisco with lobsters seems to have met with success. Of a hundred large female lobsters with eggs sent in June, 1873, from the eastern states, seven survived, and were placed in the bay. Fifteen or twenty young were lately caught by a Chinese fisherman while casting his net for shrimp.

A Record of works on geology, mineralogy and paleontology, British and foreign, will be issued by the middle of 1875, to contain short abstracts or notices of papers, books and maps published in 1874. The first volume will contain from 200 to 300 pages. Price 10s., 6d. Subscriptions should be sent to the Editor of "Nature," care of Macmillan & Co., New York.

A Society of Natural Science has lately been organized in Poughkeepsie, N. Y., with the following officers, — President, C. Van Brunt; Vice President, W. G. Stevenson, M. D.; Secretary, W. R. Gerard; Treasurer, C. F. Arnold.

Dr. J. H. Slack, of New Jersey, well known as a naturalist and pisciculturist, died August 24. He wrote on Egyptian antiquities and the mammals.

Francis Walker, the entomologist, died Oct. 5.

BOOKS RECEIVED.

Tidsskrift for Populære Fremtillinger af Naturvidenskaben. Kjobenhavn, 1874. Forste binds, fjerde haette. pp. 249-320. 8vo.

Recent Changes of Level on the Coast of Maine. By N. S. Shaler. Memoirs Boston Soc. Nat. Hist. 1874. Vol. ii. Part iii. No. iii. With cuts. pp. 321-340. 4to.

Philosophical Transactions of the Royal Society of London. 1872. Vol. 162. Part ii. pp. 241-501. and 1873. Vol. 163. Parts i and ii. pp. 662. Illustrated. 4to.

Proceedings of the Royal Society. 1872 - 1873 and 1874. Nos. 138 - 150. With cuts, 8vo.

List of Fellows of the Royal Society for 1872 *and* 1873. pp. 32 and 32. 4to.

Jenaische Zeitschrift fur Naturwissenschaft. Jena, 1874. New Series. Vol. 1. No. 1. With illustrations. pp. 176. 8vo.

Memoires de l'Academie de Dijon. Dijon, 1871. 2e Serie. Tome xvi, 1870. pp. 367. 8vo. 3e Serie, Tome ler, 1871, 1873. pp. 112.

Bulletin Mensuel de la Societe d'Acclimatation. Paris. 3e Serie, Tome i, 5, 6. Mai, Juin, 1874. pp. 257-432. 8vo.

Oversigt over det Kongelige Danske Videnskabernes Selskabs. Copenhagen, 1873. No. 3, 1874. No. 1. 8vo.

Berliner Entomologische Zeitschrift. Berlin, 1874. Tafel 1. Seite 1-8, 241-448. With illustration. 8vo.

Verhandlungen der Naturforschenden Gesellschaft. Basel, 1874. Sechster theil. Erstes Heft. Illustrated. pp. 215. 8vo.

Transactions of the Edinburgh Geological Society, 1874. Vol. ii. Part iii. With plates. pp. 247-434. 8vo.

Report of Progress for 1872-73. *Geological Survey of Canada.* Dawson Brothers, Publisher, Montreal, 1873. With plates. pp. 300. 8vo.

Zeitschrift fur Gesammten Naturwissenschaften. Berlin, 8874. Bd. ix. With cuts. pp. 568. 8vo.

The Journal of the Linnean Society. London, Zoology. Nos. 41-57. Botany, Vol. xii, and Nos. 49-56, 65-76, 8vo.

Report upon Ornithological Specimens. By Dr. H. C. Yarrow. 1871, 72, 73. Engineer Department, U. S. Army, Washington, D. C. pp. 148. 8vo.

Catalogue of Plants. By S. Watson, Engineer Department of U. S. A., Washington, D. C. pp. 62, 8vo.

The Ornamental and Useful Plants of Maine. By F. Lamson Scribner, Augusta, 1875, With plates. pp. 85, 8vo.

Twenty-Sixth Annual Report on the New York State Museum of Natural History. Albany, 1874. With cuts. pp. 192, 8vo.

Description of a New Species of Calocampa. By J. A. Lintner, Albany. 1874. pp. 2. 8vo.

On the occurrence of Tupaia Elliote, Waterhouse, in the Satpeura Hills, Central Provinces. By V. Ball, 1874.

On an ancient Perforated Stone found in the Satpura Hills. By V. Ball. Illustrated. pp. 3. 8vo.

On Habits of Some American Birds. By Thos. G. Gentry, 1874. pp. 96-110. 8vo.

The Monthly Microscopical Journal. London, 1874. No. lxxi. pp. 209-260. 8vo.

Remarks on North American Noctuidæ with description of New Species. By Aug. R. Grote. September, 1874. pp. 10, 8vo. Received Nov. 14, 1874.

INDEX TO VOLUME EIGHT.

Abutilon, fertilization of, 223.
Acanthometra, 746.
Actinophys, 745.
Acyttaria, 743.
Adelops hirtus, larva of, 563.
Adoxa moschatellina, 690.
Æcidium Parryi, 215
    psoraleæ, 215.
Æstivation of Plants, 705.
Agricultural ant, 513.
Alburnus amœnus, 334.
Algæ, 306.
    key to, 398, 479.
Allogastra, 392.
Allosorus acrostichoides, 304.
American bison, 73.
    tent caterpillar, 272.
Amœba, 741.
Amphipleura pellucida, 443.
Amphiura Otteri, 153.
Anopthalmus, larvæ of, 502.
Anser hyperboreus, 637.
Antarctic sea, temperature in, 637.
Antedon Sarsii, 146.
Anthribidæ, 468.
Ants, robber, 564.
    sweet scented, 564.
Aplonidæ, 469.
Aplectrum hyemale, 307.
Aplocerus montanus, 164.
Aplopappus multicaulis, 218.
Apple, 752.
Aquilegia Jonesii, 211.
Aramus giganteus, 89.
Archibuteo ferrugineus, 597.
Architeuthis monachus, 167.
Argas Americana, 219.
Arnica foliosa, 213.
    Parryi, 213.
Ascidia callosa, 148.
Aster Parryi, 212.
Astragalus Grayi, 212.
    ventorum, 212.
Attacus Promethea, 234.
Attelabidæ, 391.
Azalea viscosa, 517.

Baird's bunting, 241.
Bathybius, 729.
Beaver, parasite of, 427.
Beetle parasite of the beaver, 427.
Beetles, 693.
Belidæ, 470.
Birds, 434.
    American water, 108.
    migration of, 338.
    North American, 546.
    variation in, 534. [197.
    variation in notes and nesting of,
Black-breasted woodpecker, 242.
Blind crustacea, 368.
Blood, 638.
    corpuscles, 376.
    crystals, 568.
Blue grosbeak, 563.
    heron, 89.
    jay, 87.
Bombus, 686.
Bos longifrons, 136.
    primigenius, 73, 136.
Botany of Western Wyoming, 9, 102.
Botrychium lunaria, 360.
Brachiopods, 43, 46, 51, 756.
Brain, geography of, 565.
    in Tertiary mammals, 506.
Brenthidæ, 463.
Brontotheridæ, 79.
Brown-headed nuthatch, 86.
Buteo Swainsoni, 596.
Butterflies, 420.
Byrsopidæ, 395.

Calandridæ, 465.
Canker worm, 272.
Cannibalism in America, 403.
Carex tenuirostris, 214.
Caterpillars, preservation of, 321.
Centrocercus urophasianus, 240.
Centronyx Bairdii, 241.
Cermatia forceps, 368.
Cerura, 692.
Cestracion, 131.
Cetacea, fossil, 694.
Chalcis mytilaspidis, 280.
Chimney swift, 367.
Circulation, physiology of, 684.
Cirrhatulus grandis, 494.
Clymenella, 494.
Cœlenterates and Echinoderms, relation of, 430.
Cœlodasys unicornis, 691.
Colaptes auratus, 88.
Coleoptera, 303, 385, 452.
Collosphæra, 746.
Collozoum, 746.
Collurio Ludovicianus, 87.
Colorado, flora of, 304.
Colpodella, 735.
Contopus borealis, 308.
Corethra, 713.
Corydalus cornutus, 533.
Cossonidæ, 466.
Cotton worm, 562, 722.
Crab, megalops of, 495.
    zoëa of, 495.
Crustacea, 438.
    change of colors in, 556.
Crying bird, 89.
Cucullia Speyeri, 692.
Cupuliferæ, 422.
Curculionidæ, 460.
Cuttle-fishes, 107, 296.
Cuyamaca Mountains, animal life of, 14.
    botany of, 90.
Cyanura cristata, 87.
Cynips q. operator, 563.
Cyprinidæ, 436.
Cyprinoids of New Jersey, 326.

Darwin, Charles Robert, 473.
Deep sea dredgings, 431.
    explorations, 369, 755.
    soundings, 504.
Deer, antlers of, 348.

Deinamœba mirabilis, 742.
Deltocyathus Agassizii, 153.
Dendrœca occidentalis, 16.
Desmids, 181, 698.
Diatoms, 309, 371, 568, 697, 701.
Dibothrium cordiceps, 78.
Diluvium, human skeleton from, 370.
Diphtera deridens, 692.
Docophorus syrnii, 219.
Dog, 758.
Draba ventosa, 212.
Dragon fly, 432.
Drosera filiformis, 396.
    longifolia, 56.
    rotundifolia, 55.

Eared grebe, 243.
Echinus, 215.
English sparrow, 436, 667, 692.
Eudromias montana, 600.
Eudryas unio, 691.
Eugenes fulgens, 241.
Euryomia melancholica, 687.
Evolution, 439.

Falco communis, 598.
Ferns, 307.
Fish, change of color in, 556.
Fish culture, 557.
Flies, 497.
    metamorphosis of, 603, 661, 713.
Florida cærulea, 89.
    flora of, 449.
Fort Ancient, 759.
Fossil horses, 288.
Fungi, 697.

Galeocerdo, 131.
Gall flies, dimorphism in, 563.
Game falcon, 266.
Garzetta candidissima, 89.
Gentians, fertilization of, 180, 226.
Geryon, 153.
Gobiosoma molestum, 283.
Goniodes, mephitidis, 219.
    Merriamanus, 219.
Grasshoppers, 53, 502, 511.
Gregarina, 736.
Gromia terricola, 742.
    socialis, 746.

Hæmatozoa, 250.
Hair worm, 757.
Haliomma, 743.
Haplogastra, 390.
Hawks, nesting of, 596.
Heliozoa, 743.
Herbarium cases, 471.
Heterogastra, 464.
Hippasteria phrygiana, 148.
Hirundo lunifrons, 599.
Honey-ants, 365.
House sparrow, 556.
Hyalonema longissimum, 147.
Hydra, 244.
Hydrochelidon fissipes, 188.
Hydrozoa, new order of, 757.

Indian food, 247.
    pottery, 245, 694.
Infusoria, 498.
Insects, 271, 369, 507.
    organs of hearing in, 286.
    spiracles in, 531.
Ionidium, 690.
Iphiclides Ajax, 257.
Isoetes Bolanderi, 214.
Isoetes echinospora, 215.
    Nuttallii, 215.
    pygmæa, 214.

Japyx solifugus, 501.
    subterraneus, 501.

Kansas, birds of, 757.
Kinglets in New Jersey, 364.

Lagomys princeps, 15.
Lepidoptera, antennæ in, 519.
Limnanthemun lacunosum, 250.
Little chief hare, 15.
Lobster, 414, 764.
Loggerhead shrike, 87.
Loligo Pealii, 170.
    pallida, 168.

Mammals, marine, 632.
Maple borer, 57, 123.
Membracis, 565.
Menopon picicola, 219.
Microtome, 126.
Miliola, 746.
Minnow, 58.
Mollusks, 116.
Monera, 728.
Monothalamia, 743.
Mosquito, auditory apparatus of, 578.
Moths, North American, 223.
    transformations of, 691.
Mountain quail, 17.
Musca, 603, 661, 713.
Myliobatis, 133.
Myriopods, 430.
Myrmecocystus Mexicanus, 366.
Myrmica molefaciens, 513.
Myxastrum, 735.
Myxine limosa, 149.

Nadata gibbosa, 691.
Nauclerus forficatus, 88.
Nirmus buteonivorus, 219.
Noctuid moths, 421.
Notodonta, 691.
Numenius longirostris, 601.

Octopus Bairdii, 174.
Olive-sided flycatcher, 308.
Ommastrephes illecebrosa, 172.
Ophioscolex glacialis, 147.
Oreortyx pictus, 17.
Ornithology, field, 418.
    Florida, 85.
    South Carolina, 6.
Orthocarpus Parryi, 214.
Ostrich, 757.
Otiorhynchidæ, 452.
Ovary, 680.
Owls, 239.

Palæmon serratus, 561.
Pamphagus mutabilis, 742.
Pedicularis Parryi, 214.
Pelomyxa palustris, 742, 745.
Penikese Island, flora of, 198.
Peru, civilization of, 637.
Phelipæa lutea, 214.
Plant lice, 231.
Plants, Alpine, 552.
    æstivation of, 705.
    insectivorous, 684.
    water contained in, 553.
Platycerura furcilla, 691.
Platysamia Cecropia, 531.
Plectrophanes Maccownii, 602.

Plotus anhinga, 89.
Podiceps auritus, 243.
Podura scales, 376, 702.
Polistes, 229.
Polycystina, 744.
Polymorphic butterfly, 257.
Polythalamia, 743, 746.
Polyzoa, 421.
Potato, 248.
Protamœba, 729.
Protista, 731.
Protobathybius, 731.
Protohippus, 126.
Protomonas, 731, 732.
Protomyxa, 732.
Protozoa, 728.
Pseudofilaria, 740.
Psychomorpha epimenis, 691.
Pyrola elliptica, 710, 713.

Radiolaria, 743, 746.
Rainfall, 635.
Raja ocellata, 181.
Reversion of Animals, 754.
Rhine, 687.
Rhinidæ, 466.
Rhinomaceridæ, 391.
Rhizopoda, 741, 761.
Rhynchitidæ, 392.
Ribes Wolfii, 358.
Robin, 203.
Rubus odoratus, 709, 711.
Ruddy duck, 433.
Rumex patientia, 305.

Salix lævigata, 202.
  pyrifolia, 202.
Saprolegnici, 374.
Sarcophaga, 719.
  sarraceniæ, 686.
Sarracenia variolaris, 688.
Schizaster fragilis, 147.
Schkuhria integrifolia, 213.
Science, principles of, 628.
Scolytidæ, 466.
Seaweeds, 31.
Section cutter, 59.
Seeds, dispersion of, 690.
Sciurus Ludovicianus, 238.
Selachians, teething among, 129.
Sex in plants, 355.
  origin of, 19.
Silica films, 698.
Sitta pusilla, 86.
Skunk, 437.
Slide, Holman's siphon, 247.
Small-flowered Parnassia, 305.
Snakes, 432.
Snow goose, 687.
Snowy egret, 89.
Solar physics, 222.
Sparrow hawk, 266.
Sphæraphides, 638.
Sphyrapicus thyroideus, 242.
Spider, gossamer, 592.
Spiders, 361.
Spizella Breweri, 366.
Sponges, 425.
Spontaneous generation, 238.
Squid, 120.
Squids, 167.
Stanleya tomentosa, 212.
Stapelia variegata, 687.
Stingless honey-bees, 553.
Subularia aquatica, 178.
Sundew, 55.
Swainson's buzzard, 282, 596.
Swallow-tailed kite, 88.

Telea Polyphemus, 243, 753.
Termites, 553.
Tern, 433.
Territories, geology of, 216.
Testicle, 680.
Tetrapyle, 743.
Tissues for section, 191.
Townsendia condensata, 213.
  Parryi, 212.
Trilobites, 439.
Tringa ptilocnemis, 500.
Trochilium acericolum, 57.
Troglodytes, 505.
Tyrannus verticalis, 599.

Umbonia, 565.

Vampyrella, 734.
Vaucheria, circulation of, 444.

Warbler, chesnut-sided, 756.
Water Turkey, 89.
Western Warbler, 16.
  Wyoming, botany of, 175, 211.
Whale-fishery, American, 632.
Wheeler's Expedition, 683.
White necked raven, 429.
Wild cattle of Scotland, 135.
Woodlands, American, 687.
Worms, 427.
  embryos of, 46.
  segmental organs of, 51.

Xanthoptera semicrocea, 685.

Yellow-shafted flicker, 88.
Yucca filamentosa, 749.

For
USE IN LIBRARY
ONLY
DO NOT REMOVE
FROM LIBRARY

ANNEX

Stanford University Libraries
3 6105 001 265 086

FALCONER
BIOL

570.5
A512
V.18
187

NON CIRCULATING
DO NOT REMOVE
THE LIBRARY